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VOLUME 8, No. 10 OCTOBER 1956

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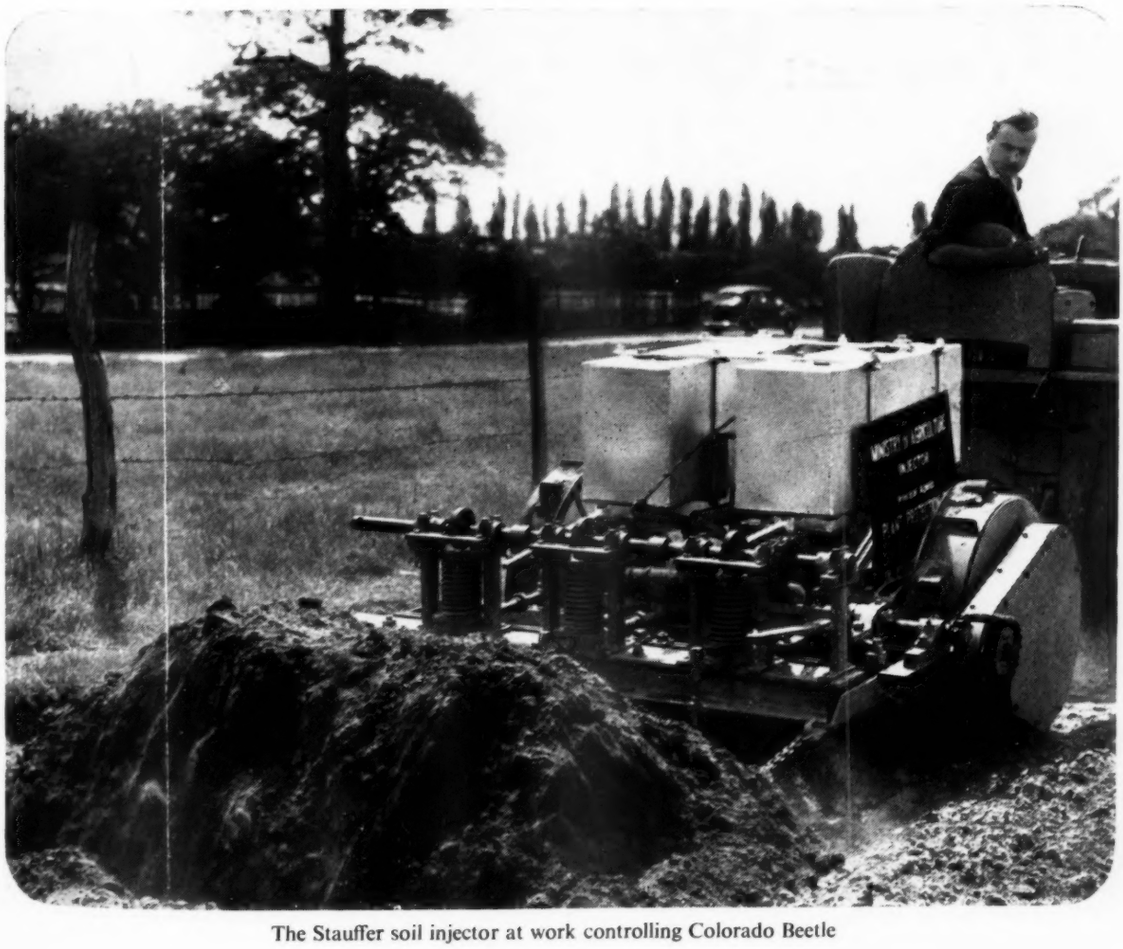

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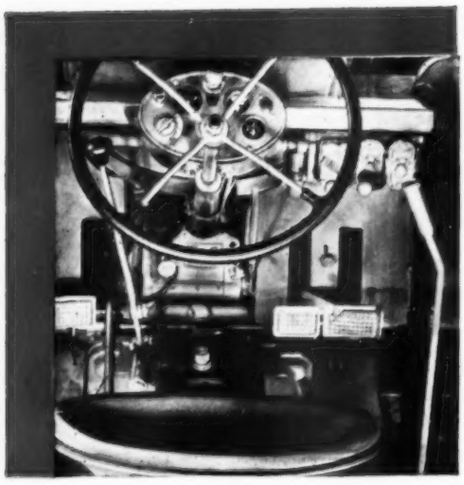

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WORLD CROPS

Vol. 8, No. 10

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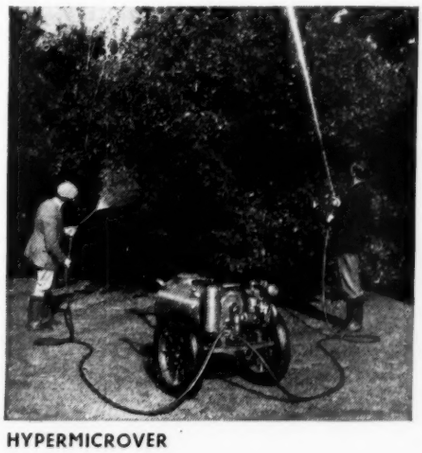
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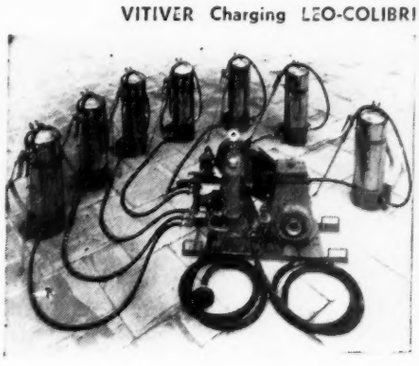

After Coffee...

TEA

Before Ceylon became famous for its tea—it was famous for its coffee. Early in the 1800s the steep green slopes of the island's hill jungle were cleared and cultivated by coffee planters, mostly Scots, and coffee soon became the major crop. Then in 1869 came disaster: a devastating blight attacked the trees and within a few years the whole industry was wiped out. So the resourceful Scots planted tea instead....

But the tea bushes of Ceylon have constantly to be protected against diseases — among them Blister Blight. Here the problem was not to find a fungicide — a copper compound was known to be effective — but to develop a technique of spraying the bushes so that the fungicide could penetrate and do its job. Plant Protection Ltd was called in and, in collaboration with the Tea Research Institute, they evolved a technique of low-volume spraying which proved completely satisfactory.

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Editorial Comment

Soil fertility and management

THE greater part of the arable soils of the humid temperate areas of the world are now employed for crop production and with an ever-increasing population the world is rapidly turning to development of irrigation in the semi-arid and arid lands, which comprise more than half of the earth's land surface. More than half the world's population is dependent on food produced under irrigation. With these thoughts in mind the author of our feature article this month provides a comprehensive and authoritative article on the management of irrigated soils. He has shown that maximum yields are dependent on such factors as fertility, plant population and characteristics, crop rotations, physical properties of the soil and soil moisture.

It is interesting to recall that the U.S. Department of Agriculture has defined soil in the following manner: 'Soil is the collection of natural bodies occupying portions of the earth's surface that support plants and that have properties due to the integrated effect of climate and living matter, acting upon parent material, as conditioned by relief, over periods of time'. Whether or not this definition is agreeable to all is not as important as the fact that we are almost entirely dependent on this 'collection of natural bodies' for our very existence. Thus it behoves us to make full use of science and technology to bring forth the great potentialities in the soil, under efficient management systems, for the sustained abundance the world so desperately needs.

Grass-seed and weed control

ALTHOUGH the hormone-type selective weedkillers can be used so successfully to deal with weed competition in grass and cereal crops grown for food, their use when these crops are grown for seed is more problematic. The danger that malformations may be produced cannot be ignored. Two years' research on the use of various weedkillers of this kind in growing four of the main species of grass for seed has been reported by the National Institute of Agricultural Botany (Great Britain). Recommendations can now be made as to the 'safe' times when growth-regulating weedkillers may be sprayed on perennial ryegrass, cocksfoot, meadow fescue and timothy. These 'safe' times are, broadly, some three or four weeks before the date of ear emergence and the actual calendar period will differ slightly, not only for the different species, but for different strains of the same species. For precise details seed-growers should consult the Institute's 36th Annual Report (1955, p. 33). It might, however, be said that the two years of research has applied only to 2,4-D; somewhat surprisingly MCPA was included in the experimental programme only in the second year.

100% increase

DURING the past ten years European farmers in Southern Rhodesia have doubled the amount of their land under cultivation. In Northern and Southern Rhodesia together a total of more than 1,500,000 acres is now being tilled by Europeans. The total value of the European output in Southern Rhodesia in 1954 was £40 million. In the same year the total value of all sales, both European and African, amounted to £53 million, but in addition the Africans in the Federation were estimated to consume about £17 million of agricultural produce. As a result of the expansion during the past ten years the Federation now exports more food and agricultural produce than it imports—the credit balance amounted to £21 million in 1954. By far the largest export item is, of course, tobacco, which accounts for five times as much of the Federal trade as foodstuffs. Although exported foodstuffs and animal, agricultural and pastoral products are worth more than £7 million imports of those commodities amount to nearly £12 million. The major single items which the Federation is having to import are sugar, wheat, butter and fish.

In spite of increasing consumption, there is every prospect that the sugar position will become happier once the Chirundu and Triangle Estates are in full production. Wheat, however, is a major problem. In 1954 £1,400,000 was spent on wheat. As the living standard of Africans is increasing more and more of them are eating bread instead of maize. Imports can therefore be expected to increase steadily during the next few years, unless experiments being conducted to find a variety of wheat resistant to rust are successful.

Altogether in the two Rhodesias there are 7,200 European holdings with a total of more than 36 million acres. Beside this total the area actually under cultivation—1,500,000 acres—appears almost ludicrously small. However, this does not take into account the vast areas used for ranching. Of Southern Rhodesia's 32 million acres held by Europeans, nearly half consists of ranches of 20,000 acres or more.

Even so, the European farm area is generally agreed to be characterised by under-development of its land resources, a failing that should be cancelled by steady development. Dr. V. M. Wadsworth, Chief Federal Agricultural Economist, pointed out in an interview with the *Rhodesia Herald* that although it was almost impossible to put a figure to agricultural production there were certain targets that should be aimed at.

Nearly 40,000 head of slaughter cattle valued at £828,457 were imported in 1954, plus fresh, frozen and chilled meats costing £111,110. 'All of this', said Dr. Wadsworth, 'could be produced within the Federation, together with sufficient to meet the expected annual increase in demand'.

There is expected to be an increase in the amount of cotton grown in the Federation, the demand for which from local mills is far greater than production. 'Nyasaland produces excellent cotton', Dr. Wadsworth stated, 'but pests and diseases have so far limited expansion there and virtually killed the crop in Southern Rhodesia. Various efforts are being made to overcome these problems'. Recently, the Federation has become self-sufficient in the production of rice. This could become a useful export crop if world prices do not continue to fall.

World wheat stocks mounting

WORLD wheat stocks continue to mount despite a decline in some countries' production and despite some pick-up in trade early this year, FAO reported recently. In the latest issue of *Mon. Bull. agric. Econ. Statist.*, FAO estimated that world wheat stocks, which increased by about one million metric tons during the 1954–55 crop year, will further increase by about 2.2 million tons by the end of the 1955–56 season.

FAO reported that higher production in Canada and Australia in 1955 more than compensated for production declines in the U.S.A. and France and a sharp drop in the Argentine. Total world production (excluding the U.S.S.R.) increased by about 5 million tons, or 3%, over the previous year. North American production this year was expected to be slightly down from that of last year, largely because of adverse weather conditions. A similar situation was expected in Europe as a consequence of the severe winter.

In the early part of the 1955–56 marketing year FAO reported wheat and wheat-flour exports were rather sluggish. But in May North American exports picked up to a marked degree and export sales from the four major wheat-exporting countries in 1955–56 were estimated at about 21.4 million tons, as against 20.4 million tons in 1954–55. The largest part of the increased exports was made by the U.S.A., which sold internationally approximately 8.5 million tons, or 1.1 million tons more than in the previous year. Canadian exports increased by about 300,000 tons and Australian exports only slightly exceeded the previous year's figures. Argentinian export sales will be short about 400,000 tons on the previous year's 3.6 million tons. Despite these increased exports by Canada and the U.S.A., decreased sales by other exporters are expected to bring final export totals for 1955–56 to about the same level as 1954–55, when world trade in wheat and wheat flour totalled approximately 26 million tons.

Grass in perspective

A WELL-KNOWN columnist who regularly writes in one of the leading British farming papers recently pointed out—with high satisfaction and a touch of surprise—that experts on grassland are not preoccupied with grass itself. Whether or not genuine experts ever were 'grass-and-nothing-but' zealots cannot easily be assessed. Specialists cannot be blamed for concentrating on their own subjects. However, there is little doubt that a good many practical farmers have felt, rightly or wrongly, that the experts look upon grass as a single end in itself and not as a part of the farming sequence. This is a regrettable view and one ill-tuned with today's farming practice. With the decline in traditional multi-course rotations many large-scale cereal farms are relying upon simple ley–cereal sequences; although the leys are well used during their lifetimes, their main purpose is to keep the land fertile for cereal cropping. Some of the farming based upon this principle is regularly producing grain yields well above the national average from soils that would hardly have been considered suitable for cereal cropping 20 years ago.

Another factor that enforces the broader viewpoint about grass nowadays is the pace with which grass output can be raised. The application of modern practices—fertilisers, reseeding, weed control etc.—can in a few years bring more grass production than many a farm can use. More stock to utilise seasonal growth requires more capital, and when a good deal of this capital must be obtained by ploughing back profits the process of increasing the farm's stock numbers is inevitably slower than the process of grassland improvement.

But these practical realities are not being ignored by grassland scientists. At the British Grasslands Research Institute several of the experiments in progress are relevant. The effects of different leys and different systems of ley management upon the yields of wheat grown after leys are being studied. In one set of experiments it has been shown that very high wheat yields (40 to 45 cwt. per acre) are obtainable after leys that have been fed with nitrogen fertiliser and frequently grazed; yields are not as high (31 to 36 cwt.) if the leys have been used for cutting and grass removal. Even so, all these yields after leys are higher than the national average for wheat. Other experiments have shown that wheat after grass–clover leys used as pasture will yield from 30 to 40 cwt. per acre, usually closer to the higher figure; but after leys grown for seed yields of wheat are appreciably lower. After clover-containing leys the use of nitrogen on wheat gives erratic results, reducing yields in some cases. Clearly the nitrogen build-up in grazed leys will often leave a heritage of this nutrient that needs no addition from the bag, and extra nitrogen supply may bring losses through lodging. But perhaps we are as yet only

beginning to visualise the full possibilities of the grass–cereal sequence. The choice of modern nitrogen-responsive cereal varieties for after-ley cropping is probably a decisive factor.

Horse population declines

FARMERS around the world are giving up horses and changing to tractors at a rate of nearly ½ million tractors per year. Figures show that the number of tractors used by farmers, not counting Russia, rose by 400,000 in 1954, reaching a grand total of 7,100,000. The biggest proportional increase has been in the least mechanised region, the Far East. There the number in use has increased from 13,000 to 20,000 in the three-year period from 1952 to 1954. That amounts to a 55% increase. Europe was next with a 31% increase in the number of tractors in use, rising from 1,270,000 tractors to 1,660,000. Africa had a 14% increase, going from 118,000 tractors in use to 135,000; the Near East rose by 12%, from 49,000 tractors to 55,000; and U.S.A. and Canada had a 6% increase, rising from 4,497,000 tractors in use to 4,778,000.

The increasing use of tractors on the farm has been accompanied by a fall in the world horse and mule population. Before the second world war there were 74.7 million horses in the world. Today there are less than 59 millions. Before the war there were 18.4 million mules and today there are about 15 millions, according to the International Federation of Agricultural Producers.

But it is a different story with the camel population. Camels are used as pack and draft animals in many countries untouched by mechanisation. The camel population is going up in Asia and Africa, rising from 7.8 millions before the war to about 10 millions today.

Hazards from pesticides

ADDRESSING the pathology section of the Manchester Medical Society recently, Dr. E. F. Edson said that, from the toxicity data for modern pesticides, it is possible to divide the important ones into three arbitrary groups. The so-called 'safe' group includes chlorate, trichloroacetate, borate, sulphur, tar oils, tractor paraffin, hormone weedkillers, copper compounds, maleic hydrazide, DDT, γ-BHC and many more recent organic compounds. The definitely 'hazardous' group comprises all scheduled poisons which require considerable care during their use, *e.g.* nicotine, arsenites, dinitrocresol-type weedkillers, volatile mercurials, and most of the anticholinesterase organophosphorus insecticides. Substances in the 'intermediate' category, which may cause illness under certain conditions, include pentachlorophenol, dieldrin, aldrin, endrin and organic mercurial seed dressings.

In the field, as in the factory, continues the report in *The Lancet*, over-absorption of chemicals usually takes place through the skin or during long-continued inhalation of mist or dust: accidental swallowing is less common and more readily avoidable. The extent of occupational risks depends on the chemical, on the system of work, on the personal habits of the worker, and on the duration of exposure. Contract spraying operators are at greater risk than private farmers, and the amateur gardener is usually protected by his short duration of use and because the most toxic chemicals are not available to him. In Britain the use of the more toxic chemicals is subject to stringent regulation, for both employer and employee; and Dr. Edson said that, so long as the educational efforts of makers, distributors, agricultural advisers, and the Government continue, there seems to be no reason why these chemical pesticides should present an impossible occupational health problem in farming.

Land reclamation experiment

IN our last issue we gave an account of land reclamation in Holland, a vast project extending over a long period of years and concerned with land reclaimed from the sea. We have now received news of another land reclamation project, but in this case it is land reclaimed from land, and is in the nature of an experiment, in Britain, extending over a period of only two years.

The industrial area in England brought great benefits but has left, in many places, a legacy of dirt and ugliness. Particularly is this so in the mining districts of Yorkshire and Lancashire, where great slag heaps form blots on the landscape and, above all, deprive the country of hundreds of acres of agricultural land. Some 30 or 40 years after mines have been worked out and abandoned, these mountains of shale remain bare, desolate and ugly. Nature, in the course of years, does its best to re-cover them with vegetation, but only the hardiest of weeds can find a precarious footing. Can anything be done to bring these barren areas back into cultivation, to cover them with grass and crops and to make them once more an economic asset in the agricultural set-up of the country?

The Lancashire County Council seem to have answered this question in the affirmative. From April 1954 to the present time they have been conducting an experiment which appears to give every promise of success and their Planning and Development Committee have published a report recently, which should be of the utmost interest to those concerned with the reclamation of land. The report is lengthy, full and detailed; it requires hard concentration by the reader, but it is well worth the effort.

This experiment in grassland establishment on colliery shale was carried out on Bickershaw Reservoir Site, Abram, Lancashire. Within two years an old colliery tip has been successfully reclaimed to pasture

land and cattle are now grazing on it. The report gives full details of the work which has proved to be an economic method of restoring this type of land without the importation of soil.

The headings of the report are comprehensive and the sections fully detailed. Commencing with an excellent resumé of the general objectives of the experiment, it passes on to describe the site and then to details of the preliminary engineering work. Then follows an account of the nature of shale, its physical characteristics, organic matter and chemical analysis. The chapter dealing with the experiment describes the various plots involved, the use of sewage sludge and gully refuse, the preparation of seedbeds, seeding, and the use of fertilisers. The two years over which the experiment lasted are divided into first-year and second-year management. The chapters dealing with these describe the weather and rainfall records, chemical analyses, results on plots, conclusions and actual production.

At the end of the report are a good plan of the site and an excellent appendix, giving detailed costs of every operation and comparative costs for the two years.

Thus acres of barren shale have been converted into good grazing land, supporting cattle with a good milk yield, at a cost little more than would normally be spent on ordinary agricultural land. The Lancashire County Council are to be congratulated on sponsoring an experiment of such value to agriculture.

Fruit quality and cultivation

THE economic value of the apple crop is not measured at the time of harvesting—the real assessment must be made later when storage losses have been deducted. A moderate crop that stores well will often turn out to be more profitable than a heavy crop which suffers from appreciable loss from lenticel rotting or low-temperature breakdown. Continuous large-scale research on these problems has been carried out in Britain by the Food Investigation Board (D.S.I.R.) in conjunction with the East Malling Research Station, and certain relationships between cultivation practice and storage quality are clearly emerging. Most of this work has concerned one variety, the Cox's Orange Pippin.

The most decisive influence seems to be the method of land cultivation in orchards. If the orchard is grassed and not openly cultivated, the apples suffer from much less lenticel rotting. Fertiliser practice also affects this aspect of quality, though less markedly than grass. However, this is an over-simplified statement. The beneficial effect of the grass in apple orchards is almost certainly the control it exerts upon the uptake of nutrients by the fruit. To quote from the latest Food Investigation Board's Report, ' no apples, whatever the manurial treatment, were as low in total nitrogen content as those from even the most highly manured grass plot '. It is already well recognised that abnormally high nitrogen content in apples induces storage rotting. However, there may be more to it than this single effect. It has also been found that apples grown on grass plots have a higher phosphorus content than those from open soil cultivation; and even the use of superphosphate dressings—unusual in fruit-growing practice—does not put as much phosphorus into apples as the grass growing in orchards. It can be speculated, therefore, whether phosphorus content is not as important a positive influence upon good storage quality as nitrogen content seems to be a negative influence.

It is surprisingly stated that potash additions are not helpful in reducing lenticel rotting—storage trials have shown that there is less rotting with apples grown on ' no-potash ' plots. On the other hand, low-temperature breakdown of apples is reduced if potash has been applied. Another quality effect of the grass cultivation method that should be mentioned is that apples grown by this method contain more ascorbic acid (vitamin C) than apples grown with similar manurial practice on open soil. This, perhaps, is of minor significance; the apple is not one of our major sources of this vitamin.

Automation: the keyword

MOST of us have read that the age of automation is at hand, but few have a very clear idea of what automation is and what consequences are likely to follow in its wake. But, again, we realise that the use of automatic control is not a new and strange thing—it is a continuation of a process that has been going on for centuries, though it has begun to move more rapidly in the last few decades. ' Automation ', says *Automation Progress*, a new journal published by the Leonard Hill Technical Group, ' is the substitution of electronic, pneumatic, hydraulic, mechanical and electrical devices, for human organs of decision and effort '.

For the manufacturer of agricultural equipment and supplies the technical advantages of automatic factories and the methods that could be employed in their planning and control are manifold—the economic advantages of automation are overwhelming and there is no doubt that it is here to stay. Therefore no technical or commercial executive can afford to be without the up-to-date information on the subject to be found in *Automation Progress*, which, seeing automation as a comprehensive industrial method, promises to keep the specialist in any sub-section familiar with the work of his colleagues in another. The first issue of *Automation Progress* appears this month and will contain, among others, articles on ' Automatic Laboratory and Analytical Procedures ', ' Plug-in Digital Computers ' and ' In-line Transfer Machines '.

MANAGING IRRIGATED SOILS

WYNNE THORNE

(*Utah State Agricultural College, Logan, Utah, U.S.A.*)

There has been a great increase in the area of irrigated land in recent years, but to obtain the optimum benefits from irrigated soils it is necessary to be aware of the soil's characteristics and the ideal methods of irrigation for particular soils. The author of this article treats fully the methods of managing irrigated soils.

MORE than half of the land surface of the earth receives less than 20 in. of precipitation a year. Under such conditions intensive agriculture is possible only with irrigation. Although irrigation developed in arid regions, today it is spreading rapidly to high rainfall areas where drought periods reduce crop yields.

Irrigated soils are world-wide in distribution. The total probably exceeds 300 million acres. Plans have been announced by 21 different nations for bringing an additional 60 million acres under irrigation through major development projects. Additional millions of acres are being placed under irrigation through small, privately financed developments.

Agriculture is in the midst of a tremendous revolution. Yield and quality of crops have spiralled upward because of improved tillage, fertiliser usage, better crop varieties, insect and disease control, and other improved practices. In irrigation agriculture the advantages of scientific farming are very apparent, because in intensive farming aimed at high crop yields moisture becomes a limiting growth factor.

Moisture control and crop yields

The key to success in irrigation farming is moisture control. Numerous experiments have shown that, with other production factors near optimum, the vegetative growth of plants is proportional to moisture availability over a range from near the wilting point to the field moisture capacity of most soils.

In experiments at the U.S. Salinity Laboratory[9] bean plants had an average green yield weight of 60 g. with a moisture stress of 1 atmosphere (atm.) (an atmosphere of moisture stress is equivalent to the force required to draw a column of water 1,036 cm. high). The greater the moisture stress the harder plants must work to draw up water. At 10 atm. stress these bean plants decreased in yield continuously to an 8-g. average. The reduced yields were comparable whether the reduction in moisture availability resulted from salt concentration or from reduced amounts of water in the soil.

In a field experiment with potatoes in Utah[7] moisture tension was carefully measured throughout the root zone. At an average moisture stress of half an atmosphere the average yield of potatoes was 550 bushels. When average stress was 3.5 atm., yield dropped to 175 bushels.

No practical method has been found to maintain soil moisture at any designated optimum moisture level. With irrigation or rainfall the soil moisture reservoir is filled. Drainage, evaporation and plant use deplete the moisture to some point where water is applied again. The point of minimum moisture depletion selected under field conditions varies with the depth and distribution of plant roots, the sensitivity of the crop to moisture stress, the value of the crop, and the cost and availability of irrigation water. Soil moisture depletion under crops usually occurs from the surface downward, depending on the depth of maximum root concentration. To keep plant roots in the surface inch or two of soil from suffering drought would usually require too-frequent irrigations. Field irrigation practices are, then, compromises between economics and the optimum water for crop growth.

To determine when to irrigate crops

[Courtesy U.S. Soil Conservation Service]

Land planes are used to complete levelling operations for improved irrigation

is one of the most difficult tasks in managing irrigated soils. Three general procedures are used: (1) observation of plants to detect the first signs of moisture stress, (2) direct or indirect determinations of available moisture in soil root zones, and (3) indirect estimates of soil moisture reserves through calculations based on climatic and soil data. Each method has limitations. Waiting for plant drought symptoms may reduce yields. The costs and techniques of soil moisture measurement limit this method to high income crops. Only technically trained personnel can carry out the measurements. Climatic data are used to determine areas where irrigation is profitable rather than as a specific guide to irrigation practice. However, recent studies of climatic data indicate satisfactory precision in the amounts of soil moisture depletion occurring under normal cropping conditions. For example, a local weather bureau might release periodic reports indicating that since the last storm of 1 July the soil moisture depletion is about 2.5 in. Then farmers can plan irrigation according to their soil and crop requirements.

Excess water is as harmful as drought to crop plants. Excess water is usually associated with poor drainage and liberal water applications. A survey of farm situations in western U.S.A. showed that on an average only 35 to 40% of irrigation water delivered to farms is actually stored within the root zone of crops. The remainder is presumably lost through deep percolation or surface run-off.

Lack of air for plant roots is the primary cause of damage by excess water. Secondary effects may also be important, including salt and alkali accumulation and the hydrolysis of lime in calcareous soils. Whatever the cause, good drainage is a requisite for successful large-scale irrigation agriculture.

Irrigation and fertility practices

When irrigation practices are adjusted to maintain the most favourable soil moisture conditions, other good management procedures start to pay off and yields increase. More plants can be grown per acre with plentiful moisture and fertilisers become more effective.

The interaction of soil moisture and available nitrogen supply is often striking in crop yields. On our experimental farms Peterson and Ballard[5] irrigated maize more frequently than average practice of the area. Yet there was no increase in yield. When 200 lb. of fertiliser nitrogen was applied per acre the yield of maize ears increased from 5.6 to 8.2 tons per acre with increased frequency of irrigations. In the same experiments the increased yield from 200 lb. of fertiliser nitrogen was 2.6 tons with average irrigation practices (2 during season) and 5 tons with frequent irrigations (7 during season). In these experiments the combination of moisture and nitrogen treatments improved quality and hastened date of maturity.

Moisture supply and nitrogen fertiliser combinations have also increased the yields of maize in experiments in Oregon,[3] sugar-beets in Utah[2] and sugar-cane in Hawaii.[1]

The effects of nitrogen and moisture seem to supplement each other, so that the increased yield from the two factors applied in combination are often much greater than the sum of increased yields from the factors applied separately. The effects of irrigation and phosphate fertiliser seem to be more nearly independent. In experiments in Arizona[6] alfalfa increased in yield with irrigation at low phosphate by 7.3 tons per acre over a three-year period. It was increased in yield by phosphate at low moisture by 5.3 tons. The combined effects of water and phosphate increased yield by 16 tons.

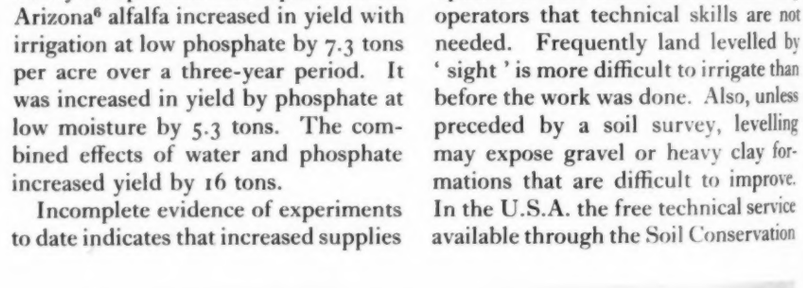
Incomplete evidence of experiments to date indicates that increased supplies of available soil moisture decreases nitrogen uptake by plants and increases phosphate uptake. At least part of the decreased nitrogen uptake with increased moisture under field conditions may result from leaching.

Power machinery

Power machinery has promoted increased crop yields through better soil manipulation and through improved timing of farm operations. In short season areas crops can be planted soon after growing conditions become favourable. The soil surface can now be shaped in beds, ridges or other desired forms to control irrigation water.

One of the greatest developments with power machinery in irrigated regions of western U.S.A. has been land levelling. This is not actually a levelling operation; the surface soil is moved to give a uniform grade. Levelling operations often greatly decrease the labour required for irrigation and increase uniformity and efficiency of water applications.

A recurring problem in land-levelling operations results from the opinion of some farmers and machinery operators that technical skills are not needed. Frequently land levelled by 'sight' is more difficult to irrigate than before the work was done. Also, unless preceded by a soil survey, levelling may expose gravel or heavy clay formations that are difficult to improve. In the U.S.A. the free technical service available through the Soil Conservation



[Courtesy U.S. Soil Conservation Service]

A farm irrigation-water storage pond in a new development area in Utah, U.S.A.

Air photo of land along the Snake River in Idaho, U.S.A., shows how water converts the desert into productive farms

Service has reduced such mistakes to a minimum.

Heavy power equipment has accentuated the problem of soil compaction. Traffic pans readily develop under the tracks of rubber-tyred tractors, particularly where operations are carried out when the soil is moist. The compact zones of soil may seriously restrict both root and water distribution. Deep-rooted legumes, such as alfalfa and clovers, help correct the problem. Deep ploughing and chisels are also useful.

Irrigation methods

Many experiments have shown that differences in method of water application do not greatly influence crop yield as long as the same levels of available moisture are maintained in the soils. In a seven-year experiment in Utah comparing sprinkler and furrow irrigation, no differences in yield of sugar-beets, potatoes, peas, small grains or alfalfa were obtained when soil moisture was comparable (unpublished data). For sugar-beets and potatoes more water was required to keep the soil moist with furrow irrigation than with sprinkling. This was especially true for potatoes. Where the tuber zone was kept continuously moist 21.4 in. of water was applied in the 1951 season in the sprinkled plots and 36.9 in. on those irrigated by furrows. With deep-rooted alfalfa the difference in water use for maximum yield was not appreciably different with sprinkler and furrow applications.

Revolving nozzles are usually used for sprinkling. Perforated pipe often delivers water at rates too fast for many soils to absorb and run-off occurs. Perforated pipe used in western U.S.A. is usually designed to put out water at rates of $\frac{1}{2}$ or 1 in. per hour. Revolving nozzles are generally calibrated for about $\frac{1}{4}$ in. of water per hour.

Sprinkling irrigation is being adopted on steep or uneven land where levelling operations are more expensive than the cost of sprinkler equipment. Sprinkler applications also give uniform water applications on sandy, porous soils.

Flood irrigation between borders and within basins requires a minimum of labour and gives excellent results with close-growing crops on land of uniform or nearly level grade.

Each method of water application is finding its place. There is no evidence that sprinkler systems will replace surface application methods on the majority of long-established irrigated farms.

Water storage

The development of sprinkler irrigation on advantageous sites is often hampered by water supply systems. Many systems have water by the turn. The size of stream is often larger than can be used with sprinkler systems and the length of turn is relatively short. Even with furrow or flood types of irrigation water is often applied ineffectively during the night. Because of these problems farmers in the western U.S.A. are constructing farm storage ponds, which usually hold between 2 and 20 acre-ft. of water. In some cases farm storage ponds can be placed at sufficiently high elevations so that at least part of a farm can be sprinkle-irrigated by gravity pressure.

Distribution and control systems

Great improvements have occurred recently in the control of irrigation water. One problem has been the waste of land in field ditches. Often these ditches become overgrown with willows and weeds. The ditches are difficult or impossible to cross with farm equipment and on sloping lands may cause erosion. In intensively farmed areas and on high-priced lands the shift is toward underground reinforced concrete pipe with periodic risers to deliver water to particular points. Although expensive, the savings in land and water often offset much of the cost. The additional savings in labour or irrigation and the positive control of stream sizes further favour installations of this type.

One reason farmers apply improper amounts of water is a lack of knowledge of how much is being used. For this reason educational programmes are urging each farmer to have at least one water-measuring structure on his farm. Usually the device is a rectangular or notch weir with an appropriate set of conversion tables.

Plastic pipe is being used in a few cases for replacing temporary field lateral ditches. Curved siphon tubes have been widely accepted to take water from field ditches and regulate it into irrigation furrows.

Water quality

Most of the 17 western states of the U.S.A. have released at least one publication during the past five years on

the composition of irrigation water. There is growing recognition that the amount and kind of salt in irrigation water distinctly influences yields, soil properties and irrigation and soil management practices.

The U.S. Salinity Laboratory[8] has recently published graphic standards for classifying irrigation water. This system has been generally adopted in the U.S.A. Criteria are total salt as measured by the electrical conductivity of the water, and the proportion of sodium compared with calcium and magnesium in the water. In addition, it is recognised that chlorides may be injurious to fruit crops and that bicarbonates may increase sodium effects and contribute to lime-induced chlorosis.

Salt and alkali

Saline and alkali soils are common in arid regions and are often increased by irrigation. Saline soils are those containing salt, and alkali soils are those with excessive amounts of sodium absorbed on the clay. Control and reclamation measures are being constantly investigated. No new basic concepts have occurred in this field in the past 25 years, but new techniques are being developed.

Soil permeability is the most significant factor in controlling or removing salt and alkali in soils. Where water can be moved through soils, salt is removed and sodium can be readily displaced from clay by calcium. Drainage and leaching are the standard reclamation and control practices for salinity. Reclamation of alkali soil requires soluble calcium, which often occurs in irrigation water. Gypsum is commonly added to supply additional calcium. Recent experiments in California[4] show excellent results with sulphuric acid for reclaiming alkali calcareous soils. On an equivalent sulphur basis sulphuric acid treatment was superior to gypsum in crop response and equivalent sodium replacement. Sulphur treatments were not beneficial during the two-year experiment reported.

Careful analysis of soil and leaching water before initiating reclamation has come to be a standard practice. Procedures and calculations similar to those recommended by the U.S. Salinity Laboratory are in general use to estimate required gypsum or other treatments and the contributions of irrigation water to reclamation.

For soils that cannot be fully reclaimed certain principles are being used to avoid some of the harmful effects of salt.

1. Keeping salt away from germinating seeds and young seedlings, and
2. Removing or reducing salt concentration in some part of the plant root zone. Planting on the side of a sloping ridge permits the salt to rise through the soil toward the top of the ridge away from the roots. Frequent irrigation down furrows in the root zone keeps salt leached away from a zone below the furrows. Roots develop and remove water from this low-salt area.

Crop varieties

Plant breeders are developing new crop varieties adapted for high yield and quality under irrigated conditions. Small grains are bred with short stiff straw that will resist lodging. Other crops are being bred for greater salt tolerance and erect growing habits. These new varieties are being selected for high-yielding ability under favourable soil fertility and moisture conditions.

Integration

Great yield increases are coming from integrating all management factors. No longer can irrigation practice, tillage, fertiliser treatments or crop varieties be considered alone. Each practice must be planned to fit in with other practices. Integration of optimum production factors is boosting crop yields. As the yields increase timing becomes more important. A few days' delay in irrigation or fertiliser application may seriously decrease yields. Here the technician enters the picture. Soil-moisture-stress measurements, soil and tissue tests for available nutrient supply and frequent observations for insect pests and diseases become increasingly important.

Only a few growers of large quantities of high-priced crops have entered this field of integrating production factors on a scientific basis. We are, however, gaining experience and devising improved practices. When the demand becomes sufficiently great the newer practices of irrigation agriculture can tremendously increase the world food supply.

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Farm mortgages in the U.S.A. recorded in the first half of 1955 totalled $1,312 million. This figure is higher than in any six months' period since the U.S. Department of Agriculture began keeping records in 1934.

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TEA SOILS AND THEIR MANAGEMENT

C. R. HARLER

It has been said that the characteristic flavours that distinguish the teas of one district from another are derived from the soil. However, this claim has not been established in India, Ceylon or Java, where much of the world's tea is grown. Nevertheless, the soil per se *is an important factor in the culture of tea and in this article Mr. Harler sets forth at length many little-known facts about tea soils. He deals with their geological origin, physical characteristics, the effects of soil acidity and the presence or lack of trace elements. The author then concludes with a discussion on soil management in India and Ceylon.*

ALTHOUGH tea has been grown and prepared for many centuries in the villages of China and Japan, the tea-planting industry did not start till 1839, with the formation of the Assam Company. About 1875 Ceylon took up tea planting after the failure of coffee in the island. Serious development did not take place in Java till 1900 and in Eastern Africa still later, about 1920. Over the past 80 years plantation procedure has changed a great deal, of course, and crops have steadily increased in yield from 300 lb. of tea per acre in 1880 to an average of 800 lb. today, with the best estates making 1,500 lb. and over. This increase has been due to improved methods of planting, pruning, plucking and soil management, to the use of high-yielding types of tea and to the application of heavy doses of sulphate of ammonia.

Tea soils have been under scientific study in India, Ceylon and Indonesia for about 60 years and much information is available on the subject.

Geological origin

The tea areas of the world are planted on soils derived from widely different geological formations. In North-east India the best tea is grown on Quaternary and recent alluviums, whereas the rest is mainly on soils formed *in situ* from gneisse and sandstones below. In South India and Ceylon much of the tea is planted on soils resulting from the weathering of Archaean rocks. The soils of Java consist of the products of eruptive rocks and most of the tea soils are derived from the weathering of volcanic ash, sand and lava of the Tertiary period. In Africa the soils come from granites, gneisses, sandstones and more recent deposits of volcanic activities.

The geological origin of a tea soil is not of importance, provided the latter has had time to weather and lose excessive lime by leaching. Tea will not grow on limestone soils or soils that have recently been flooded by alkaline water.

Tea, like many other plants, prefers a deep, friable, well-drained soil, generously supplied with plant food, but it can be grown on poor soils and made to flourish there if well fertilised. In China and Japan it is often relegated to hillsides where other crops would fail.

Physical characteristics

The tea plant will thrive on a soil of practically any texture. In North-east India successful tea soils range from the lightest of sands to the stiffest of clays, and include silts and loams of all types. Some of the sands hardly merit the term soil, for they are merely collections of rock particles on which chemical changes due to climate have had, as yet, little effect. On the other hand, some of the yellow clays are so stiff that they would be unworkable but for the marked dry season which puts tilth into them.

In Cachar, in the Surma valley of Assam, tea grows vigorously on peat soils which are left after *bheels* or swamps have been drained, although the water table may remain a foot or two below the surface both during the monsoon and the dry season. The roots of the stand in such places only descend a few inches and the whole bush can be shaken in its flimsy foothold. In other areas in North-east India the water table descends to a considerable depth in the dry season and unless the bushes are deep rooted they are left high and dry and suffer during the drought. Drainage is essential under such circumstances.

In Ceylon and South India the soils are old and have become red and lateritic in contrast to the ugly, grey soils usual in Assam. Many consist mainly of sand and clay with a silt fraction of 10% or so. There is little difference between the top and subsoil in physical make-up, a fact which suggests that in some cases the original top soil has been dissipated by erosion and what is left is largely subsoil. Many of the tea fields in Ceylon and South India are stony and strewn with rocks and boulders.

Areas that have recently carried forest are best suited to tea planting because they are rich in plant food and are in good tilth. The natural vegetation of all tea land is forest, but in many parts of India, Ceylon and East Africa the trees have been removed ages ago and the land grazed. More work is necessary to develop these grasslands, but they can produce as good yields as forest lands in due course, provided there has not been erosion.

Classification of tea soils

Climate is the ultimate factor that determines the make-up of a soil and, given time, in due course a certain set of climatic conditions will produce related soils from minerals that were very different originally. Under the wet conditions of Western Europe, with free drainage and temperatures

generally below 59° F., the water passing through the soil leaches out iron and aluminium to form eventually a soil classed as a podsol. Such soils also occur in the uplands of tropical regions, above 6,000 ft., where temperatures are below 59° F. Much of the chemistry of podsolisation remains obscure.

When temperatures are above 59° F., as in most tea areas, the leaching in a freely drained soil removes bases like lime and magnesia, as in the case of podsol formation, but silica is washed through rather than iron and aluminium. In this way the proportion of iron and aluminium increases and the soil becomes red in colour, owing to the presence of iron oxide. These changes are termed laterisation and the soils are described as lateritic or *latasols*.

Laterisation

The study of laterisation began as early as 1807 in the Western Ghats of South India, in connection with the decomposition of acid igneous rocks, such as granites and gneisses. Bricks made from dried laterite are commonly used for building on the Malabar coast and the word laterite is derived from the Latin word (*later*, brick). The final stage of this laterisation process is laterite, a mass of red nodules composed practically of the oxides of iron and aluminium. The course of decomposition does not necessarily follow that described for South India and soil science now recognises other forms of laterite, dependent on the parent rock and type of drainage.

Measurement of laterisation

Some measure of the degree of laterisation was at one time based on the ratio of silica to the oxides of iron and aluminium in the clay fraction of the soil. If this were less than 2, it was assumed that much silica had been leached out and the soil was said to be lateritic. On this basis laterised soils have been reported in the tea areas of Formosa, South-east China, Indonesia, Ceylon, East Africa and Nyasaland. In South India soils from well above 6,000 ft. have all the visible signs of laterisation and a silica/sesquioxide ratio well below 2. The tea soils of North-east India are assumed to be lateritic, but no analytical data are available. Japan tea soils have been described as podsols.

Soil acidity

The nature of tea soils, formed by the intensive leaching out of bases, ensures that they shall be poor in lime and acid in reaction. Between 1915 and 1925 in North-east India small doses of limestone, up to 10 cwt. per acre, were periodically applied in tea estates. This treatment followed on reasoning from first principles in agriculture in vogue at that time, for it had been found in temperate regions that certain soil bacteria worked better in the presence of lime. By 1925 it was shown in field experiments that even small doses of lime depressed the tea plant, and equivalent doses of sulphur, which reformed the acidity, revived the plant. Accordingly the addition of lime was discontinued.

Causes

Practically all good tea soils in North-east India show pH values close to 5.4, which seems to be indicative of soils that have weathered under conditions there. The peat or *bheel* soils of Cachar, which may contain 50% of organic matter, have pH values of 4 to 4.5, but the acidity is of an organic nature.

The tea soils of South India and Ceylon have pH values ranging from pH 4.6 to pH 6.0, with extreme values of pH 4 and pH 7. In Japan the most satisfactory values are between pH 5 and pH 6. In Nyasaland and East Africa the common range is pH 4.6–6.2. In the Caucasus values are about pH 5.0–5.4.

The intensive study of the acidity of tea soils began in Assam in 1920. It was first thought that tea needed an acid soil solution and that lime, as such, was only a subsidiary factor in that it reduced acidity. Then odd areas in Assam, the Dooars, South India and East Africa with pH values of almost 7 were found occasionally to grow good tea. It was then thought that these soils, although almost neutral, might still be short in lime, and that tea was a calcifuge, avoiding lime, rather than a plant demanding acidity. Another more recent explanation is that since acid soils contain comparatively large quantities of readily available aluminium and manganese, which the tea bush consumes and stores in relatively large quantities, it is the need for these elements that makes essential an acid soil for tea.

In some estates weak patches of tea are traceable to the burning of heavy timber during clearing operations, and such areas are found to be ' under-acid '. Old village sites and house sites are infertile to tea, a well-known fact in India, Ceylon and Africa, and attempts to make them fertile usually fail. The addition of sulphur, fertilisers, cattle manure or green crops in economic quantities does not enable these patches to carry good tea. Analysis shows such places to be ' under-acid ' and rich in phosphates.

Calcium is, of course, essential to all plants. The dry matter in tea contains about 0.55% of lime, so that a crop of 1,000 lb. of tea removes 5½ lb. of lime from the soil. Tea probably gets its lime from weathered soil minerals and any odd calcium salts. It may, if pushed, get some of the exchangeable calcium from the clay lattice.

Treatment

When sulphate of ammonia is added to the soil the acidity is increased and some of the lime washed out. In England it is stated that for each 1 cwt. of sulphate of ammonia added to the soil the equivalent of 1 cwt. of limestone is washed out. In the case of an acid soil, with no free limestone, the calcium may be detached from the clay lattice, but whether or not leaching from acid tea soils is as serious as the washing out of lime in England is not known.

In Assam, over a period of 20 years, the pH of the soil has been reduced from 5.4 to 4.6 after annual doses of sulphate of ammonia, giving about 2 cwt. per acre. How far the available lime content has been reduced is not known. The total lime in a good Assam tea soil is about 0.2%, of which about half is considered available to the plant. Corresponding figures for Ceylon and Java are a little higher. In Assam the available lime in the top 9 in. of an acre of soil is about 2,500 lb., sufficient to supply lime to an annual crop of 1,000 lb. of tea for about 500 years. However, if leaching is serious, this quantity might well be washed out by sulphate of ammonia in a few years.

Food of the tea plant

The original object of analysing soils physically and chemically was to give advice on manurial and cultural treatment. Many thousands of full analyses have been made on tea soils in most tea countries, but, although these are an essential part of any soil survey it

has not been found possible to interpret the analysis in the form of practical advice. No chemical method has been found for measuring in a soil the amount of plant food that is available to the plant and the only way to find what a plant needs is by field experiment, the results of which often run counter to analytical data.

In North-east India sulphate of ammonia is usually added alone, because experiments with potash and phosphoric acid show no crop increase as a rule. Doses up to 600 lb. per acre giving 126 lb. of nitrogen, are economic, although 400 lb. per acre is the rate commonly used, and with this dose, containing 84 lb. of N, each pound of N given produces about 8 lb. extra of tea. With higher rates of application the response falls. Presumably the acidity of the sulphate of ammonia breaks down the soil minerals at a sufficient rate to keep the bush supplied with its needs. How long this process can go on without developing an absolute shortage in some essential foodstuff is a matter for conjecture, but the industry is well alive to this danger.

T.R.I. mixture

In Ceylon nitrogen as sulphate of ammonia is used, together with potash and phosphates. Nitrogen and phosphates give crop increases independently, so that the effect of two of them equals the sum of either alone. Doses of 20 to 30 lb. of potash per acre (or phosphoric acid) are about the optimum and higher quantities give no further crop increases. Sulphate of ammonia up to 400 lb. per acre increases out-turn by 4 to 5 lb. of tea per lb. of added N, a figure much below that realised in Assam, perhaps because of the different types of bush grown in the two countries.

The fertiliser used at present in Ceylon is called T.R.I. (Tea Research Institute) mixture, which is added in quantities according to the crop removed. This mixture contains sulphate of ammonia, muriate of potash and saphophosphate, the last being a rock phosphate supplying, in addition to phosphoric acid, calcium and magnesium and small amounts of sulphur, iron, manganese and copper, all of which are just as essential to tea growth as N, P and K. Analyses of Ceylon rocks show them to be inherently poor in potassium, calcium and magnesium and the T.R.I. mixture contains all these elements.

This illustration shows clearly, particularly in the bank in the background, the deep red Ceylon soil

Magnesium

The leaves of the tea plant in some Ceylon areas indicate a magnesium deficiency in the soil and to overcome this a 5-cwt. dressing of dolomite, a calcium/magnesium carbonate, is recommended. Alternatively, the addition of 1 lb. of Epsom salt (magnesium sulphate) to every 10 gal. of copper spray used against blister blight is being tried out, for this would avoid the possible consequences of the addition of a basic mineral like dolomite to a soil that may already be ' under-acid ' for tea. When used in the spray fluid the magnesium would be absorbed through the foliage.

Trace elements

This discussion leads naturally to the trace elements needed by the plant. In Nyasaland on some areas at certain times there appears to be a shortage or non-availability of sulphur in the soil to young plants, which suffer from a leaf disease called Yellows. The addition of sulphur to the soil as the element or dusted on the leaves, or added to the soil as sulphate of ammonia, eliminates the state producing the disease. Young plants usually grow out of Yellows, apparently by becoming able to draw upon the sulphur in the soil.

In a small limited area of Nyasaland a shortage of copper in the tea leaf occurs, and the tea grown in that area does not ferment satisfactorily, appar-

ently because of a shortage of the oxidising enzyme, which is a copper-protein compound. Spraying the foliage with Bordeaux solution overcomes the trouble in a few days and one spraying lasts in effect for a couple of years. The problem does not end here, however, for *commercial* and not pure copper sulphate must be used in the Bordeaux mixture, and this contains cobalt as an impurity.

Mycorrhiza

In Nyasaland, by spectrographic analysis, the trace elements in fine tea leaf have been found to include mainly aluminium and manganese, each of which vary between 500 and 1,000 p.p.m. in the dry leaf. Iron is present at about 75 p.p.m., boron 40, zinc 35, copper 12 and nickel 5 p.p.m. Traces of strontium, barium, chromium, tin and lead have been detected.

In Ceylon the copper content of the leaf is about 25 p.p.m. and zinc ranges from 25 to 42 p.p.m. Molybdenum and boron have not been detected.

The tea plant is a luxury feeder with respect to potash and phosphoric acid and after a certain stage extra minerals go to storage in the plant and do not increase the crop. In the same way trace elements are probably assimilated and stored if present in comparatively large quantities in the soil. This may explain the different copper contents of tea grown in Nyasaland and Ceylon. On the other hand, it is possible that bushes or types which ferment well or poorly do so by virtue of some inherent capacity to take copper from the soil.

It may be noted here that the part of the tea rootlets just behind the tip is associated with soil fungi, mycorrhiza, which may supplement the work of the root hairs. This endophyte, which does not occur on the roots of seedlings, but appears on older plants, lives in a form of mutually beneficial symbiosis with the plant. Mycorrhiza were observed many years ago in Assam and have recently been under study in Ceylon. It is possible that their presence in plenty or in few may be correlated with other factors, perhaps the nature of the plant and its capacity to call indirectly on the food within the soil.

Influence of soil on quality

In China the characteristic flavours that distinguish the teas of one district from another are ascribed by Chinese farmers to the soil. Similar views are held in Japan. There is no scientific evidence in India, Ceylon or Java to show that quality goes with certain chemical or physical properties of the soil.

Experience in both India and Ceylon show that the inherent qualities of the bush far outweigh any other factor, be it climate, soil or even fine plucking, in determining the quality of the tea produced.

Nitrogen, whether in organic form as cattle manure or chemical form as in sulphate of ammonia, affects quality adversely, though to a small extent. Even with applications of 400 lb. of sulphate of ammonia per acre tasters cannot consistently detect any deterioration in quality. Potash manures have no effect on quality in Assam, but tend to improve it in Ceylon. Phosphoric acid has a slightly good effect on the quality of Assam teas, but none on those of Ceylon.

Soil management in India and Ceylon

Brief mention may be made of tea soil management in North-east India and Ceylon, mainly in order to emphasise their differences. Most of the tea area in North-east India is on dead flat land, and broad sheets of tea as level as a table are the rule. In Ceylon practically all the tea is planted on slopes, with all the disadvantages of erosion and soil exposure that go with them.

In Assam many fundamental changes in soil management have taken place in the past 40 years. At one time the soil was deep hoed yearly and light hoed once a month, if possible. Trenching was the rule and prunings and organic matter were buried to 18 in. Phases of planting leguminous shade alternated with their uprooting and removal. About 40 years ago complete fertiliser mixtures were given; now usually all that is used is sulphate of ammonia.

Shade

Experiments from 1920 onwards showed that soil disturbance *per se* was either harmful or waste of effort. Green stuff, such as prunings, left on the soil surface to rot was found to do as much good as if it were buried. One scrape hoe a year, followed by three or four rounds of sickling of the weeds, was found to be sufficient to keep the soil clean in a well-grown, closely planted area.

The types of tea planted in Assam, the Assam and the Burma strains, are shade-demanders and if grown under a cover of leguminous shade trees, such as the *Albizzia stipulata* or *A. odoratissima*, planted 40 ft. × 40 ft., whereby the light intensity is reduced by 50%, the crop increase is as much as that given by 400 lb. of sulphate of ammonia. If sulphate of ammonia is added to tea shaded in the manner described, the effect of the fertiliser is halved and its use may become uneconomic.

Silvicultural method

Thus the tendency in Assam is towards a kind of silviculture, in which tea, planted and pruned so that the bushes meet, is grown under a shade canopy. The soil is little disturbed neither physically by cultivation, nor chemically by fertilisers. The deep-rooted shade trees bring up mineral matter from below and shed leaves on the soil rich in nitrogen fixed from the atmosphere. In this manner trouble regarding plant food shortages may possibly be postponed indefinitely.

In Ceylon the soil is deep forked to about 12 in. each year and organic matter is pushed into the envelope made by moving the fork backwards and forwards. The soil is clean weeded. There is little leguminous shade compared with that grown in India and the addition of fertilisers is essential to produce an economic crop.

Differences between the methods followed in the two countries are mainly due to differences in climate and the lie of the land. If practicable, the aim in Assam, to return towards forest conditions, must be preferable to present Ceylon procedure.

Photo: Tea Bureau, London.

FAO Council Honours France's Mayer

The Council of FAO heard recently that a series of research fellowships will likely be named in honour of the late Prof. André Mayer, of France. Prof. Mayer, an outstanding French scientist, who had been closely connected with FAO since its earliest days, died at the age of 8[illegible] in Paris earlier this year.

Cure and Prevention of Virus Diseases in Plants

F. C. BAWDEN, M.A., F.R.S.

(Deputy Director and Head of the Plant Pathology Department, Rothamsted Experimental Station, England)

Research on the virus diseases of plants has advanced rapidly during the past decade. In this time the possibility of curing a plant infected with a virus disease has become an established fact. The author, a distinguished scientist in this field, devotes most of this article to describing the advances made in the cure and prevention of virus diseases.

WHEN I spoke to the Royal Society of Arts in 1945 on 'Virus Diseases of Plants' all I could do when describing control measures was to indicate the possibilities of breeding resistant varieties and the benefits from destroying infected plants and to outline the health certification schemes for vegetatively propagated crops. Particularly I could point to the success achieved in raising vigorous stocks of potatoes in the north and west of Britain, where the aphis *Myzus persicae* is relatively scarce and inactive and where removing infected plants can not only maintain the health of a stock, but even improve it. Of insecticides, the best I could report was that 'little success has so far attended their use', and then add that 'the testing of insecticides is only yet in its infancy and the future may be brighter than past results indicate'. I did not mention that some infected plants could be cured or that substances were known that inhibit infections by viruses, but the potential value of this was then far from evident. Now, partly to compensate for my past omissions and partly to show the advances in our subject, I propose to discuss the cure and prevention of virus diseases.

Heat therapy

Plants lack the antibody-forming mechanisms of animals and once a plant becomes systemically infected with a virus it usually remains so for the rest of its life; even worse, offspring produced vegetatively from infected plants are also infected. The first suggestion that permanent infection, although customary, need not necessarily be accepted as inevitable came 30 years ago, when Wilbrink and Houtman showed that immersing sugar-cane cuttings in hot water could free them from sereh and chlorotic streak, two suspected virus diseases. Kunkel established the point unequivocally in 1935 by showing that peach trees were cured from yellows if they were kept for 14 days or more at 35° C. Peach trees were also freed from some of their other viruses by this treatment and by immersing dormant twigs for short periods in hot water. Later Kunkel found that keeping *Vinca rosea* and *Nicotiana rustica* at 40° C. freed them from viruses that cause yellows-type diseases, and that small potato tubers were freed from witches' broom virus after six days at 36° C.

Kunkel's pioneering did not lead immediately to any extensive testing of heat therapy, perhaps because the properties of the viruses he used were unknown, so that the cures could be explained by postulating that the viruses were all exceptionally susceptible to inactivation by heat. Interest in heat therapy was aroused in Britain in 1949, when Kassanis showed that potato tubers could be freed from the leaf-roll virus by keeping them for 10 days or more at 37° C. This is also a virus that has not been transmitted mechanically and whose resistance to heat *in vitro* is unknown, but it soon became obvious that heat treatment might also be applicable to curing plants infected with viruses that have high thermal inactivation points.

Inhibitors of infection. A French-bean leaf rubbed over its whole surface with the same preparation of tobacco-necrosis virus; the left-hand side, rubbed with virus alone, shows many necrotic lesions; the right-hand side, rubbed with virus and inhibitor (mushroom juice), is healthy

The ease with which plants contract infection, the extent to which viruses multiply in them, and the symptoms they show, depend greatly on their physiological condition, and hence on the conditions in which they are growing. Each or all of these three features are affected by differences in manuring, watering, light intensity and, above all, by temperature. Treatments that make plants more liable to become infected are not those that also necessarily increase the extent to which viruses multiply or the severity of symptoms they cause. Indeed, with variations in temperature, the opposite is more generally true. Keeping plants at high temperatures much increases their susceptibility to infection, so that a given inoculum may give 10 times as many local lesions in leaves of plants that have been kept for two days at 36° C. before inoculation as in those kept at about 20° C. This effect has been found with all the viruses yet tested. By contrast, keeping plants at 36° C. after they are inoculated usually de-

TABLE 1

EFFECT ON MEAN NUMBER OF LOCAL LESIONS OF KEEPING PLANTS AT 36° C. BEFORE OR AFTER INOCULATION WITH VARIOUS VIRUSES

Virus and host	*Plants at 36° C. Before inoculation for*			*Plants at 36° C. After inoculation for*		
	0	1 *day*	2 *days*	0	1 *day*	2 *days*
Rothamsted tobacco necrosis (90)* in bean	2	29	46	69	0	0
Tomato bushy stunt (80) in *N. glutinosa*	18	83	97	65	9	2
Cucumber mosaic (60–70) in tobacco	15	45	78	144	0	0
Tobacco mosaic (93) in *N. glutinosa* ..	32	98	111	25	18	19
Tomato spotted wilt (45) in tobacco..	86	197	165	173	121	96

* Figures in brackets are the temperatures (° C.) at which the viruses become inactivated in ten minutes *in vitro*.

creases the number of lesions produced. Some viruses produce almost as many lesions in plants at 36° C. as at 20° C., whereas others give few or none. The ability of a virus to multiply and produce lesions in leaves at 36° C. is not correlated with its resistance to heat, at least not as this is customarily measured *in vitro* by finding the temperature at which infectivity is lost after 10 minutes. Two of the viruses listed in Table 1 have unusually high thermal inactivation points and yet fail to form lesions at 36° C., whereas tomato spotted wilt virus, which has the lowest known thermal inactivation point, does.

Conditions in cells differ so much from those in leaf extracts that there is no *a priori* reason to expect a connection between the ability of a virus to maintain itself in plants at high temperatures and its behaviour when heated *in vitro*. Altering the temperature at which plants are grown can be expected to alter their metabolism and could alter the relative activities of systems needed for virus synthesis and systems that destroy virus particles. Changing temperature greatly affects the rate at which viruses accumulate in newly inoculated leaves. Table 2 shows that increasing temperature up to 22° C. greatly increases the rate at which a tobacco necrosis virus accumulates, but with increases above 22° C. the rate falls. From this kind of study it is impossible to decide whether the virus fails to accumulate at the higher temperatures because it multiplies more slowly or because it is being broken down more rapidly. Other experiments, however, suggest that the high temperatures encourage host systems that break down the virus particles. For example, when plants that have become systemically infected with tomato bushy stunt virus at 20° C. are placed at 36° C. the infectivity of leaf extracts soon falls. At first this fall is not accompanied by a comparable fall in the amount of protein serologically related to the virus, suggesting that an early change leads to loss of infectivity without disrupting the virus particles, a type of change readily produced *in vitro* with this kind of virus. After about three weeks no virus is usually detectable either by serological or infectivity assays. Such plants are not always virus-free; when returned to 20° C. many develop systemic symptoms again after a few weeks, presumably because virus survived in a few cells, perhaps in the main root or stem. If cuttings are struck from pieces of these plants at the end of their sojourn at 36° C., however, some usually develop into virus-free plants. Exposure to 36° C. also decreases the virus content of plants systemically infected with many other viruses and, although it does not free them, may still be used to produce healthy progeny. Viruses that can maintain themselves at high temperatures seem not to move freely into new tissues and cuttings struck from shoots produced by plants at 36° C. may be virus-free.

Whatever the explanation of heat therapy, its wide application has already been shown by freeing many different kinds of plants from some of their common viruses. Its practical value in giving healthy clones of varieties now universally virus infected is too obvious to need stressing and its main use probably lies in producing small 'nuclear' stocks for specialist propagators. However, when immersion in hot water will cure, a wider use becomes possible, and ratoon stunting of sugar-cane is now controlled in Australia by a routine hot-water treatment. It seems, too, that, quite unbeknown, heat has long been operating therapeutically for the potato crop in the plains of India. Two potato varieties are mainly grown there: one, Darjeeling Round Red, of which new supplies of 'seed' are brought regularly from the hills because the tubers do not survive the summer in the plains, and the other, Phulwa, maintained locally. Leaf roll is frequent in crops of Darjeeling Round Red, but not in Phulwa. At least it is rare unless 'seed' has been kept in the modern setting of a cool store, when it becomes frequent. Work at the Potato Research Institute, Patna, suggests that Phulwa has maintained its vigour, not because it is intrinsically resistant to leaf roll, but because its small tubers survive high temperatures and tubers taken from plants that become infected while growing in the winter lose the virus while stored through the hot summer.

Inhibitors of infection

The fact that high temperatures can free plants from viruses does more than provide a method of curing some infected plants. It shows that, without permanently damaging plants, their metabolism can be so altered that they no longer support the multiplication of viruses to which they are normally hosts. This suggests the possibility of similarly altering the metabolism by other means, for if the reactions of plants to high temperatures prohibit

TABLE 2

THE EFFECT OF TEMPERATURE ON THE RELATIVE CONTENT OF ROTHAMSTED TOBACCO NECROSIS VIRUS IN INOCULATED FRENCH BEAN LEAVES

Temperature, C.	*Relative virus content at time after inoculation*		
	23 *hours*	47 *hours*	71 *hours*
10	1	3	37
14	2	422	3,935
18	31	3,875	33,750
22	208	19,100	158,000
26	79	3,015	7,550
30	6	97	263

virus multiplication, why not reactions to other physical or chemical stimuli? There is already evidence that it can be done: unfortunately, none of the things I shall mention promises to be an effective therapeutant, but they supply pointers to the future and some may function as prophylactics.

For example, leaves exposed to appropriate doses of ultraviolet radiation immediately resist infection by mechanically transmitted viruses to which they are normally susceptible. The resistance is temporary if the leaves are kept in visible light after irradiation, but permanent if they are not. During the resistant period some mechanism is diverted to counteract the damaging effects of the radiation and this seems not only to prohibit virus multiplication, but also to destroy virus particles that enter the cells.

Viruses can be inactivated in the epidermal cells of systemically infected plants by irradiating them with ultraviolet, but the technique has no therapeutic value, because the radiation has little penetrating power and cannot free deep-seated tissues. Viruses can be inactivated by many other kinds of radiations and some that penetrate deeply may have therapeutic value, but the problem has not been studied and there is no evidence to show whether viruses could be inactivated *in vivo* without also permanently damaging the host plant.

The effect of ultraviolet in making leaves resist infection can be attributed to changes in the host-plant metabolism, because the virus particles are never exposed to the stimulus. There is no such easy conclusion about the action of substances that inhibit infection, for both virus and host are exposed to them. Many substances do inhibit infection, and they are very varied chemically, ranging from proteins and polysaccharides, through polypeptides, to purine and pyrimidine analogues and some other small molecules. Inhibitors of viruses are common components of organisms; they occur in leaves of many plants, of which the most studied are *Phytolacca* sp., beet, carnation and sweet william, in many fungi, in fruit juices, milk and blood. Their action has been studied chiefly by mixing them with mechanically transmissible viruses *in vitro* and comparing the infectivity of the mixtures with comparably diluted virus on its own. Some of the most studied, for instance the enzymes ribonuclease and trypsin, and a glycoprotein from *Phytolacca* sp., combine with virus particles *in vitro*. This provides a conveniently simple explanation for their action, for it can be postulated that, in combining, they block some group on the virus particles that needs to be free if the particles are to infect. The inhibitors do not permanently inactivate the viruses and the combination may well be incidental to rather than a cause of inhibition, for there is no fixed ratio of virus to inhibitor that neutralises infectivity. Also, the extent to which infection is prevented depends largely on the species of the host plant inoculated rather than on the identity of the virus in the inoculum.

Curing growing plants with heat. Upper plant, a virus-infected Abutilon, showing the typical bright variegation; lower, a healthy plant produced by striking a cutting from a variegated one kept for 28 days at 36° C.

TABLE 3

THE RELATIVE EFFECTS OF DIFFERENT SUBSTANCES IN INHIBITING INFECTION IN TWO HOSTS

Substance	*Tobacco mosaic virus in* N. glutinosa	*Tobacco necrosis virus in French bean*
Ribonuclease 0.01%	5	0.5
Polysaccharide from *T. roseum* 0.05%	1	13
Trichothecin 0.01%	48	25
Trichothecolone 0.01%	30	70
Acetyltrichothecolone 0.01%	2	90
Water control	100	100

Host specificity

In interpreting their mode of action it is worth noting that the inhibitors from leaves of plants have little effect in preventing infection of the species that contain them; sap from carnation leaves, for example, does not prevent carnation ringspot virus from infecting

carnations, but does prevent it from infecting tobacco or French bean. Then, the fungus, *Trichothecium roseum*, produces two inhibitors, one a polysaccharide and the other, trichothecin, which is also an anti-fungal substance, has the molecular formula $C_{19}H_{24}O_5$, and is an ester of the ketonic alcohol trichothecolone. Although they both behave in the same general manner as other inhibitors, their action cannot be attributed to blocking essential groups on virus particles, because neither combines with virus particles *in vitro*. They show different host specificities, for trichothecin inhibits infection of French bean more than of *Nicotiana glutinosa* and the polysaccharide inhibits infection of *N. glutinosa* more than of bean. Table 3 shows this and also how changing the constitution of a substance slightly can greatly change its ability to inhibit infection in different kinds of plants, acetyltrichothecolone completely reversing the action of trichothecin and inhibiting infection of *N. glutinosa* strongly, but having no effect with French bean.

Many inhibitors do not injure leaves even when applied at many times the concentration needed to inhibit infection. Trichothecin does and it injures French bean, in which it inhibits infection, much more than *N. glutinosa*. By contrast acetyltrichothecolone and trichothecolone both damage leaves of *N. glutinosa*, but not of French bean, and these inhibit infection of *N. glutinosa* more than of French bean. These phenomena suggest that inhibitors function by affecting the host plants. What they do is unknown and there is no need to assume that they all do the same thing. All that needs to be postulated is that, on entering cells, they somehow disturb their metabolism so that introduced virus particles are precluded from multiplying, and that could happen in many different ways.

For our purpose it is less important to know how these inhibitors work than to appreciate that entirely innocuous substances exist that can make plants resist infection by viruses to which they are normally susceptible. When sprayed over leaves their effects can last for several days. Their behaviour superficially resembles that of a protective fungicide, although they function differently. Instead of interfering with the pathogen on the outside of the leaf, they penetrate with it and then prevent it from multiplying. These substances have large molecules and, like the viruses, enter leaf cells only through wounds. To inhibit infection they must enter with the virus or immediately afterwards. Whether or not they could be used prophylactically as sprays in crops has yet to be tested critically. They do not make leaves resist infection when viruses are introduced by aphides and their use, if any, is likely to be limited to controlling the few viruses that are mainly spread mechanically. Prime among these is tobacco mosaic virus, which occurs in Britain throughout the tomato crop and causes losses more than enough to justify extensive trials to see whether or not the inhibitors can check its spread. Too much should not be expected from them, but they warrant testing.

The inhibitors with small molecules that have so far been studied show less promise of having practical uses. They are soon absorbed into leaves and have only transitory effects in conferring resistance against viruses; also they can severely damage the host plants. The one most studied, thiouracil, interferes with the multiplication of tobacco mosaic virus in tobacco even when it is not applied until a day or more after the leaves became infected. This at first sight suggests a quite different mechanism from the other inhibitors, but this is not a necessary conclusion, for it may only reflect the fact that thiouracil penetrates deeply into leaves, whereas the inhibitors with large molecules cannot. It does not act therapeutically, for tobacco mosaic virus already formed is not destroyed; it is prevented from multiplying further, perhaps simply because it is prevented from spreading to, and becoming established in, new cells. If thiouracil acts by interfering with the nucleoprotein metabolism of the host it, or something else with a comparable action, might possibly act therapeutically against less stable viruses than tobacco mosaic. Some of these may maintain themselves only by continued synthesis and preventing their synthesis for some days might produce a virus-free, still viable host. Certainly the idea is worth testing, for it might lead to a method for freeing clonal varieties or even to curing virus-infected trees.

Indeed, the increasing prevalence of serious virus diseases in many kinds of trees is perhaps the greatest stimulus to seeking therapeutants. About all that can now be recommended as a control measure is to destroy infected trees. This is good advice, for it certainly does something to safeguard still healthy trees, but it does not exactly endear the plant pathologist to those who own affected orchards, cocoa farms or avenues of fine elms. They would care little that a curative treatment was temporarily damaging, provided it prevented the loss of capital entailed in the death of trees. And the total capital losses in cocoa and citrus alone now amount to many millions of pounds sterling.

TABLE 4

THE EFFECT OF INSECTICIDES ON THE SPREAD OF TWO POTATO VIRUSES

Treatment	*Leaf roll*	*Virus Y*
DDT emulsion ..	1.3*	3.9
Malathion ..	0.0	6.0
Endrin	0.4	5.0
Systox	0.4	4.2
Unsprayed ..	37.5	18.5

* Results are recorded as the percentage of the plants, in the five on either side of infected ones, to which the viruses spread.

Use of insecticides

The attempts yet made to control virus diseases in trees by insecticides have not been promising, but that does not mean that methods will not be found. It was not so long ago that spraying with insecticides was also proving of no value in annual crops such as sugar-beet and potatoes, but with the development of persistent insecticides the position is altering rapidly. It is still too soon to be sure how useful insecticides will prove, but that they can decrease the spread of viruses like beet yellows and potato leaf roll there is now no doubt. Our present experience can perhaps be most simply summarised by saying that persistent insecticides properly applied to a crop will not usually prevent virus diseases from being introduced into that crop from outside, but they can prevent the spread of some viruses from infected to healthy plants within a crop. Thus their efficacy depends greatly on how outbreaks originate. If, as is usual with potato leaf roll in Britain, spread is mostly from plant to plant within a crop, and only a few plants become infected by infected aphides coming from distant

Potato virus diseases: the plant on the left is healthy; the centre plant is suffering from leaf roll; the plant on the right is infected with mosaic caused by virus Y. Tubers can be freed from leaf-roll virus by storing at 36° C., but not from virus Y

crops, then spraying can be valuable. Similarly, with sugar-beet, provided there is not a nearby source of yellows virus and aphides to supply many incoming infective insects, the customary increase in infected plants during the summer can be checked and an economic return obtained from spraying.

Viruses are individual things and to generalise about the ability of an insecticide to check the spread of viruses within crops is as dangerous as to generalise about their other properties. Two viruses of one crop may have the same insect vector, but the spread of one may be prevented by an insecticide and the other not. Spraying potato crops, for instance, may stop leaf roll from spreading, but not virus Y (see Table 4), although both are transmitted by the same aphides, mainly *Myzus persicae*. This difference reflects differences in the speed with which an aphis can acquire and transmit the two viruses. After first feeding on a plant with leaf roll, an aphis cannot infect a healthy plant for some hours, so that insecticides can kill it before it can transmit the virus. By contrast, an aphis can acquire virus Y within a minute of feeding on an infected plant and can then immediately infect a healthy one, a process altogether too rapid to be interfered with by current insecticides. Many of the problems in controlling virus diseases would be overcome by the discovery of a persistent substance that either kills insects immediately they alight or acts as a repellant and prevents them from even settling on plants. It is probably asking a lot, but it is an order well worth trying to fill, for it would not only stop the spread of viruses within a crop, but also prevent them from being introduced into the crop.

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Photos: Rothamsted Experimental Station, Harpenden, England.

Atomic Radiation May Ripen Fruit

A radiation process which will ripen fruit and vegetables instantaneously is under study in the U.S.A. If perfected it will mean that fruit and vegetables can be picked before they are ripe, transported for long distances and ripened artificially on arrival.

The process was reported to a recent meeting of the American Chemical Society at Dallas, Texas, by Dr. Malcolm C. Henry, of the Research Division of the U.S. Army Quartermaster Corps. Dr. Henry said it was under study as part of the Army's search for better methods of food processing and preserving. The equipment needed for it, he said, is compact enough to be carried into the kitchen of a small Army unit, or into any ordinary kitchen, and used there.

Acetic acid conversion

The Quartermaster Corps has been working for several years to develop methods of preserving food by atomic radiation. It was while attempting to perfect this process that researchers saw the possibility of employing radiation for artificial and quick ripening of food products. They found that irradiation of certain chemicals in unripe fruit produced the same chemical changes as those that occur in natural ripening.

For example, Dr. Henry said, the sour taste of an unripe apple is caused by acetic acid. As the apple ripens the acetic acid is converted gradually into several other acids, which give the mature fruit much of its flavour and aroma.

The key to the new atomic process was the discovery that irradiation converted acetic acid instantaneously into the various other acids hitherto formed during the long ripening period.

Colonial Agricultural Officers Visit British Research Station

A successful course for Colonial Officers ended recently at Chesterford Park, Essex, England, the research station of Fisons Pest Control Ltd. Three years ago the company were considering ways of disseminating up-to-date information to overseas countries and this course is one outcome of the discussions. The course is held in co-operation with the Colonial Office, who nominate the delegates to attend. This year 26 nominations were received, of which 22 people attended.

The course assembled at Chesterford Park and the visitors toured the research laboratories, engineering works, chemical works and demonstration plots of the company; they attended lectures on pest-control problems, with lectures devoted to the main crops in each territory and with special reference to peasant agriculture. They discussed application techniques and the economics of crop protection; they handled spraying machinery and as much useful information as possible was packed into their course by the lecturers and demonstrators, many of whom have first-hand knowledge of the territories where the agricultural officers work.

Solar Energy—II

Solar Power Units and the Future

A. V. BRANCKER, PH.D.

In this, the concluding part of his article, the author places considerable importance on the role of solar energy in chlorella farming. It has been said in some quarters that the money required to develop chlorella projects could more profitably be spent on educating local farmers in backward countries, but it is maintained that if experiments in solar energy were pursued with the speed devoted to nuclear developments, such opinions would soon be modified.

IN regions where conventional fuels are not readily available and where solar intensities are high the application of solar power units, particularly for the generation of steam, is of some importance. A steam unit developed in 1913 is shown in Figs. 5 and 6. It consisted of five parabolic sections, each 205 ft. long and 13 ft. 5 in. wide. The mirrors were of flat glass, $\frac{1}{16}$ in. thick, silvered, coated with shellac and cut in various sizes to fit the parabolic section. Some operating data for this unit, which are given in Table 7, illustrate the possibilities of converting solar energy into low-pressure steam power adequate for many practical purposes.

As will be seen from Figs. 5 and 6, this type of solar steam unit occupied an extensive area of ground. Smaller and more compact power units are necessary. These could be a modern development of the historical solar calorific engine shown in Fig. 7. Whatever methods of utilising solar energy are developed, the success or failure will depend mainly on radiation intensities. It is, therefore, necessary to make a closer study of solar radiation, not only from the aspect of modern power units, but also in biological and chemical processes.

Radiation

The term radiation is of extensive application and includes electric waves of low frequency, infra-red, visible, ultra-violet sections of the spectrum, and extends to high-frequency *X*-rays.

Photochemical radiations, however, are located mainly in the visible and ultra-violet regions from wave length $\lambda = 2{,}000$ Å to $\lambda = 8{,}000$ Å. The percentages of total energy radiated from the sun, T = 6,000 °K, which has been computed from spectral emission curves, are given in Table 8.

It will be seen from Table 8 that the radiation in the infra-red at 6,000 °K is three times greater than the ultra-violet emission.

Now, according to the Quantum Theory, light is absorbed in quanta or photons, $h\nu$, where h is Planck's constant and ν is the frequency of the absorbing radiation. The energy *E* absorbed by 1 mol. of substance is given by

$$E = Nh\nu = Nhc/\lambda$$

where N is the Avogadro number.

Putting $N = 6.025(10^{23})$,

$h = 6.61(10^{-27})$,

$c = 2.9977(10^{10})$,

$E = 2.854(10^5)/\lambda$ kg.cal./mol.

where *E* is termed the Einstein.

Since visible light extends from $\lambda = 4{,}000$ Å to $\lambda = 7{,}600$ Å, these values correspond to 71 and 38 kg.cal./mol., which indicate the energy orders involved. According to the law of photochemical equivalence, postulated by Einstein, 1 mol. of substance should react for every $2.854(10^5)/\lambda$ k.cal of radiation absorbed.

There are many examples of photochemical reactions, but one relevant to the present discussion is the formation of carbohydrates from carbon dioxide and water. This reaction, which can be expressed by

$$CO_2 + H_2O + h\nu = \tfrac{1}{6}[C_6H_{12}O_6] + O_2$$

requires 112 k.cal./mol. of energy. In a plant, however, and in the presence of chlorophyll, it proceeds at $\lambda = 7{,}000$ Å, which is equivalent to 38 k.cal./mol. In general, what is termed the quantum efficiency of photosynthesis is low and has been quoted at 0.05–0.1 mol. of carbon dioxide per quantum. The quantum efficiency of photosynthesis is of importance in any project where a food or fuel is to be produced by solar radiations. According to Putnam, the total carbon fixation in the U.S.A. in one year amounted to some $0.05(10^{18})$ B.Th.U., which, compared with an incident $50(10^{18})$ B.Th.U., was about 0.1%.[8] This means that some 99.9% of the solar energy was unconverted by photosynthesis.

TABLE 7

Barometer, in.	29.9	Area of solar radiation intercepted, sq. ft.	13,752
Wet bulb temp., °F. ..	76.6	Boiler heating surface, sq. ft.	2,819
Dry bulb temp., °F. ..	88.4	Land area occupied by absorber, acre	0.88
Humidity, %	58	Area occupied/area radiated	2.77
Feed water temp., °F. ..	111.6	Rate of heat absorption, B.Th.U./sq. ft. of heating surface	116
Steam pressure, lb./sq. in. ..	8.3		
Weight of steam, lb./h. ..	1,430		
Evaporation, lb./h./sq. ft. of surface	0.53		
Thermal efficiency, % ..	55.8		

TABLE 8

Percentage of total energy	*Wavelength*, Å	*Range*
14.2	$\lambda < 4{,}000$	Ultra-violet
43.4	$4{,}000 < \lambda < 7{,}600$	Visible
42.5	$\lambda > 7{,}600$	Infra-red

It follows, therefore, that artificial means must be adopted to improve natural conversion efficiencies.

Chlorella farming

In this connection particular attention has been given to chlorella, one of the single-celled algae; a rootless plant which absorbs energy through the entire visible spectrum. There are some 17,500 algae, each of which can produce some 50 different strains. It is possible that one or more of these will contribute to both food and fuel needs of the future.

Chlorella has been grown at a quantum efficiency of about 10% and at a computed yield of 75 tons per acre per year. It is a fine, greenish-yellow powder containing about 54% of protein and has a calorific value of approximately 10,000 B.Th.U./lb.

At present the cost of a chlorella fuel electric power unit is some 40 times that of a conventional coal-fired unit, but this cost can, no doubt, be reduced as more knowledge is obtained.

Chlorella farming as visualised for the future will be based mainly on a continuous process in a closed system where nutrient solution, carbon-dioxide enriched, flows through polythene bags containing the growth.

Again, the cost of chlorella production exceeds that of coal, but the gap can perhaps be closed somewhat by a thorough investigation of the operating conditions.

Some overall equations of photosynthesis given by Wassink are

$$(a)\ 6.85\ CO_2 + 6.4\ H_2O + \overline{NO_3} \rightarrow \rightarrow (C_{6\cdot85}H_{11\cdot8}O_{2\cdot65}N) + 9.7\ O_2 + \overline{OH}$$

where the efficiency is given by

$$\varepsilon = \left\{ \frac{\text{calories fixed}}{\text{calories absorbed}} \right\} 100 = 23.5\%.$$

$$(b)\ 24.5\ CO_2 + 20.2\ H_2O + \overline{NH_4} \rightarrow + \rightarrow C_{24\cdot5}H_{42\cdot3}O_{12\cdot5}N + 28.6\ O_2 + H$$

where, in this case, $\varepsilon = 15.1\%$.

The two different compositions indicate the flexibility of the reactions from the aspect of proteins, fats, sugars etc. These experiments were carried out in sodium light over 4–7 days at a maximum intensity of $2(10^4)$ ergs/sq. cm.sec. Attention is also drawn to the high quantum efficiency of this process compared with some 0.2% for many agricultural crops.

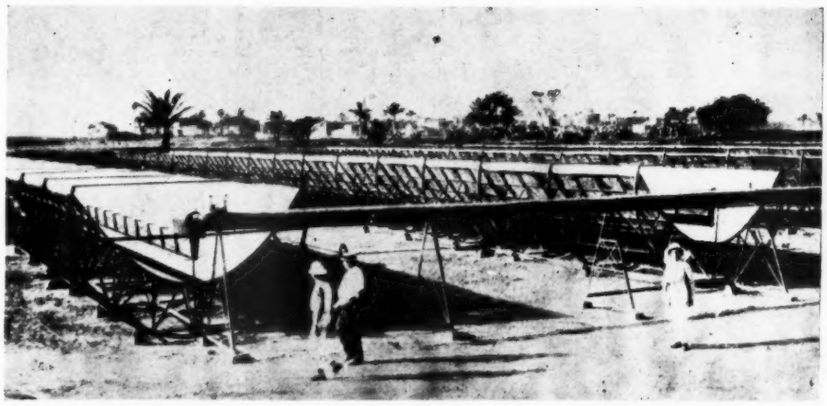

Fig. 5. The Meadi solar absorber has five sections each 205 ft. long and 13½ ft. wide. Mirrors of flat glass were silvered and cut to form a parabolic surface. This apparatus produced some 1,442 lb./h. of steam with a thermal efficiency of 56%

Since sodium light corresponds to the mean of the visible solar spectrum, it may be expected that algae cultures under conditions which permit the absorption of 20% of the incident radiations below 7,000 Å may yield some 200 tons of dry material per year per ha. of calorific value about 10,000 B.Th.U./lb.

In addition, therefore, to the food value, chlorella has a fuel potential that may well be used in those regions where fuel is in short supply.

The development of a pilot plant or commercial chlorella unit needs laboratory data in which many variables are studied. Extensive investigations are in progress by Wassink and in America a pilot plant has been operated by Little.[8] Preliminary cost estimates are not promising and more competitive design and operation is necessary if large-scale chlorella projects are to receive official support.

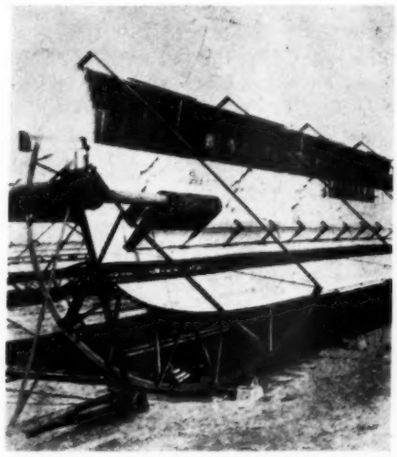

Fig. 6. Another view of the Meadi solar absorber, showing boiler, parabolic mirrors and circular rack. Automatic movement is controlled by a simple thermostatic device

Solar power units

For a solar power unit the requirements in simple terms are a parabolic mirror, which concentrates the sun's rays on a dark absorbing liquid, the temperature of which is thereby increased. The liquid is circulated through a heat exchanger and steam generated.

A parabolic mirror rotating on an axis parallel to that of the earth was employed, for example, by Abbott.[7] The surface of specularly reflecting 'Alcoa' had a reflecting power of 82% under clear conditions and an intake of 138 k.cal./min. on a surface of $120(10^3)$ sq. cm.

Some 72% of the reflected rays were absorbed by 'Arochlor', which was circulated through a heat exchanger to generate steam.

There are, of course, many possible designs of reflecting surface, but the most practical, perhaps, is of composite form where the components, of suitable basic material, are coated with a highly reflecting metal film, such as rhodium. Precise details of construction would unduly lengthen this discussion. It is, perhaps, sufficient to explain that the absorbing liquid, preferably of high boiling-point, can be contained in double-walled globes located at the focus of small cross-section.

Both concentration and conservation of heat is necessary in the system and circulation of the heated liquid to the heat exchanger can be natural or forced.

Proceeding on the basis of 138 k.cal. intercepted per minute, and assuming

an engine efficiency of 75% and a 0.4% thermodynamic efficiency, Abbott estimated that 21.3 k.cal. were convertible to mechanical energy. In order to generate 1 kW. of steam, a collector diameter of about 10 ft. would be required and tracking mirrors on a 2-mile line at 138 k.cal./min. intensity would supply 10^6 kW. of steam.

According to Putnam, the collector diameter for a 1-kW. steam generator in New Mexico would be approximately 16 ft. and tracking mirrors on a 70-mile line would meet the 1950 work component of the U.S.A.[8]

At present no estimates are available on the costs of such solar power units, but, obviously, the first consideration is the economic design of reflecting surfaces to which attention is being given.

There are other solar projects under investigation, each of which merits separate discussion. A comprehensive study of solar space and water heating has been made by Heywood.[9] The construction and application of solar cookers is discussed by Ghai *et al.*[10] and some very interesting work on solar furnaces is in progress by Trombe.[11]

Some aspects of solar energy are discussed in a British report which appeared in 1952.[12] A symposium on the subject was held in America in 1953[13] and a conference, also in America, was held recently.[14] It is, perhaps, necessary to correct any impression that solar energy applications are a modern scientific vogue; attempts to utilise the power from the sun date from very early times.

There are, however, many biological, chemical, physical and engineering problems which have to be solved before solar power or food production units can become economically competitive with conventional processes. n this connection opinions differ on the possibilities of solar energy applications. It has been expressed in some quarters that the money required to develop chlorella projects, for example, could be more profitably spent on educating local farmers in backward countries. If experiments in solar energy were pursued with the speed of nuclear developments, such opinions would soon be modified. Even so, the need for education or training in modern agricultural methods is of considerable importance; this is kept well in mind by UNESCO and associated agencies who are pursuing with imagination and vigour many problems of international importance, including solar energy applications.

Fig. 7. Ericsson's solar calorific engine. An early example of the conversion of solar energy into motive power in a small, self-contained unit

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Technical News

The October issue of *Automation Progress* will include articles on 'Automation of Laboratory Analytical Procedures' by D. A. Patient, 'Materials Handling for Automation' by F. T. Dean, and 'The Fully Automatic Plant' by Prof. R. H. Macmillan.

The contents of *Food Manufacture* for October will include articles on 'Automatic Control in a Biscuit Factory,' 'East Africa's First Margarine Plant,' and 'Plant Proteins and Vitamin B_{12}'.

Manufacturing Chemist for October contains articles on 'Planning and Controlling Research in a Pharmaceutical Company' by T. F. Davies Haines, 'Health and Hygiene in the Fine Chemicals Industry' by T. Dewing, and 'Application of Chelating Agents' by A. E. Frost.

Included in *Chemical & Process Engineering* for October is an article on 'Corrosion and Construction Problems of Sulphuric Acid Plant' by G. C. Lowrison, B.SC., A.M.I.CHEM.B., and F. Heppenstall.

The October issue of *Dairy Engineering* includes articles on 'Mechanical Causes of Sub-normal Milk' by H. R. Ealey, 'Butter and Cheese Grading in Practice' and the 'Cooling of Milk at the Production Point'.

The contents of the October issue of *Muckshifter* will include 'Building a Road Embankment Across a Bay' and 'Tunnel Constructed by Dropping Steel Tube in Under-water Trench'.

Floors for October will include an article on 'Chemical-resisting Industrial Flooring'.

Improving Cyprus Citrus Crops

The biggest ever campaign against the Mediterranean fruit fly was launched in Cyprus this autumn, where it is estimated that the insect causes about £250,000 worth of damage to fruit crops annually.

With the support of Cypriot farmers, the Cyprus Department of Agriculture made spraying and other treatment compulsory in areas where the fruit fly is prevalent. The Department's Plant Protection Section, which last year carried out large-scale experiments, had more of its officers in the field than ever before, advising farmers in techniques of fruit fly destruction.

In 1955 Cyprus exported oranges to the value of £722,487, grapefruit £202,081 and lemons £192,950.

Dutch Centre for Plant Physiological Research

Plant physiological research in the Netherlands has recently been co-ordinated by setting up a foundation, 'Centre for Plant Physiological Research', which will, among other things, give information and advice to physiologists employed in agricultural research and provide them with working space and apparatus.

The director of the 'Centre for Plant Physiological Research' is Dr. M. H. van Raalte, of the Laboratory of Phytopathology of the Agricultural University, Wageningen.

Biological Control of the Prickly Pear

DR. T. J. NAUDE

(*Chief of the Division of Entomology, Department of Agriculture, Pretoria*)

Following the great success in controlling prickly pear (Opuntia inermis *and* O. stricta) *in Australia with the insect* Cactoblastis cactorum *it was decided to use the same method of control in South Africa. However, owing to various reasons the method had to be modified. In this short note Dr. Naude surveys the steps taken to combat prickly pear infestation in South Africa and suggests what can be done in the future.*

THE idea of biological control in South Africa of the prickly pear, *Opuntia megacantha*, originated as a result of the resounding success achieved in Australia in this connection with the aid of the insect *Cactoblastis cactorum*. Australia, however, had to cope with species of prickly pear totally different from those encountered in the Union of South Africa. It is only on the dwarf prickly pear species, *Opuntia inermis* and *Opuntia stricta*, which occurred on an extensive scale in that country, that this insect has had the desired effect. The Union consequently first sent a consignment of our prickly pear pest to Australia with a view to ascertaining whether or not it is susceptible to *Cactoblastis*. Very fortunately, indeed, the insect was able to live on this species of prickly pear. Thereupon an expert was sent to Australia in order to study the technique locally and to bring back a consignment of *Cactoblastis* eggs. Local breeding operations were undertaken with this consignment of eggs and susceptibility tests with plants of economic importance were repeated locally. When the latter yielded negative results the first large *Cactoblastis* breeding station was established at Graaff-Reinet and subsequently two others were instituted at Uitenhage and Fort Beaufort.

No certainty whatever existed in regard to the measure of success the insect was likely to achieve locally on a species of prickly pear which differs radically in its nature from the Australian dwarf prickly pear and which is not the insect's natural food. The undertaking was, however, based on good hope.

Selected localities

After eggs for distribution had been produced for several years at the respective breeding stations, and colonies had been placed in various selected localities and then left to nature, it gradually became apparent that, within limits, the insects were performing excellent work. In due course all prickly - pear - infested areas in the eastern Cape Province were provided with colonies. As in Australia, the insects caused extensive destruction of the smaller plants, which are comparable in size and quality with the dwarf prickly pear, and consequently the pest was greatly reduced. At most places, however, the large, vigorous prickly pear clumps, which in point of fact were *trees*, remained standing, partly because the insect is apparently not inclined to place its eggs at a greater height than 5 to 6 ft. from the ground, but also partly due to ecological reasons. Something had therefore to be done to bring these large plants under control. Once again a consignment of prickly pear was sent to Australia with the request that it should be tested against the most likely species of which approximately 130 had been imported by that country. In due course it was reported that the cochineal insect (*Dactylopius opuntiae*) had shown positive possibilities. A consignment of this cochineal was received, bred in cages, and the progeny eventually placed at various points in the veld. The insects increased splendidly wherever they were settled and reached a population peak within an average of 18 months after the establishment of a suitable colony. At this stage the plants, including the large trees, began to succumb on an extensive scale, and by 1940 the second stage of the campaign was reached when further large-scale thinning out of the prickly pear took place. By this time all the biological districts had once again been provided with the new insect and fairly general collapse of the pest occurred. As in the case of *Cactoblastis*, there were patches where markedly less success was achieved owing to the great diversity of ecological conditions in the prickly-pear area. It was consequently decided to lay out experiments at numerous points with a view to determining whether the felling of infested plants, when the cochineal insect had reached its population peak, would not have the desired effect. Everywhere resounding success was achieved and farmers throughout the prickly-pear area were actively encouraged to participate in the felling of the pest and so deal the final death blow.

Opportunity lost

Apart from the usual reaction of the public in such affairs—on the one hand it was regarded as a State undertaking, and on the other it is, unfortunately, the layman's general conception of biological control work that it can be wholly effective in itself. It was at that time the middle of the war years, so that many farmers were absent from their farms and other matters engaged the attention of the country's manpower. It was, therefore, tragic to observe that nothing whatever was

being done and that the opportunity was gradually beginning to slip away despite the dozens of eloquent demonstration plots along the main roads which even today furnish proof of how felling at the given moment can eradicate prickly pear. The reason for the retrogression was that the cochineal insect began to develop local natural enemies which soon curbed the activities of the insects to such an extent that only exceptionally favourable conditions enabled them to build up to sufficient numbers to become an encouraging destructive force once more.

Government scheme

In 1944 a scheme was eventually devised whereby the Government undertook a State-sponsored felling programme, in which a start was made with prisoners of war and in which subsequently native labourers were employed. These gangs of workers felled all the existing remains of prickly-pear plants in all the main infested areas but, in many cases it was, unfortunately, too late. The optimum opportunity had been lost and, furthermore, the gangs could not be employed on a part-time basis, with the result that felling had often to be undertaken irrespective of whether the cochineal population was reasonably high at that moment or not. The result was that, although the pest as a whole was undoubtedly brought under control over the major part of the infested area, and consequently no longer presents a problem at the moment, complete control was not achieved in certain patches. This applies particularly to certain high-lying and cold, mountainous parts of the country where neither *Cactoblastis* nor the cochineal insect has ever reached its full potential. No careful survey has yet been made of these areas, but mention can be made *inter alia* of the vicinity of Pietersburg, Swagershoek, Cradock, parts of Bedford, Fort Beaufort, Somerset East and particularly the coastal belt to the south of the Suurberg Mountains, in which alone approximately 50,000 morgen (about 100,000 acres) of dense prickly-pear occur. In the latter parts, incidentally, *Cactoblastis* never proved satisfactory, due to the fact that it contracted a disease in the comparatively moist coastal belt. Here, too, the cochineal insect, although it might at a certain stage have been able to win the battle with the aid of felling, was not only checked by predatory beetles, but in course of time also contracted a fungus disease which continually hampered its progress.

In so far as these two insects are concerned, the coastal belt in particular will apparently continue to present a permanent problem. As regards the problem patches in the Karoo, the position is more encouraging. In certain parts, such as, for example, the neighbourhood of Pietersburg, where individual farmers are making a special effort to give the cochineal active assistance by redistribution in an intelligent felling programme, the campaign appears to be making slow but sure progress.

Furthur importations

In the meantime various other insects were also imported and used experimentally. Two of these, the beetle *Moneilema ulkei* and the moth *Cactoblastis doddi*, proved so unpromising that they never got beyond the cage experiment stage. Two others, the stem-borer beetle, *Lagochirus funestus*, and the leaf-borer beetle, *Cactophagus spinolae*, were bred in large numbers and liberated at various places, but without any particular practical promise. The former apparently finds local field conditions too unfavourable and gradually dies out in the veld. *Cactophagus* breeds reasonably well in the veld, but its multiplication potential is disappointing and consequently it breeds and spreads so slowly that, after four years since its first liberation, we can entertain little hope of its eventual usefulness.

In these circumstances serious consideration was given to the possible importation of further species of insects. Since, however, we have undoubtedly already made use of the best species which are known to science and which we dare employ, the prospect of additional importations are not very promising unless a special search is made afresh. Such a search would be worth-while if modern chemical herbicides fail to offer a more direct and profitable solution.

Other expedients

It should, however, be fully realised that absolute success, in the sense of complete eradication of any pest by biological means alone, is an unreasonable result to expect. At most all that can be expected is a reasonable measure of control, since the basic nature of the process is a stabilisation between the pest and its natural enemy. By great good fortune stabilisation may occur with the numbers of both at a low level. If further progress is desired (for example, complete eradication of the pest), then it always remains necessary to give biological control active assistance by having recourse to additional expedients, and these must generally be resorted to without any delay since the best opportunity of doing so may not continue to present itself for any length of time. The only other alternative would be to entrust the problem to some body armed with the necessary powers to enable it to take action as the circumstances demand, as has, in fact, been done in Australia.

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Southern Rhodesia Plan for Farm Settlers

The Southern Rhodesian Government has accepted in principle a scheme to settle selected immigrants from Germany, Holland and Italy on farms. The scheme has been put forward by Dr. H. G. Weizmann, of the Inter-Governmental Committee for European Migration, and a beginning with two land settlement pilot schemes is envisaged this year. Dr. Weizmann is an acknowledged world expert on land settlement and has been largely responsible for farming settlements in Israel. He is at present the Inter-Governmental Committee's adviser on this subject.

Each pilot scheme—one in Southern and one in Northern Rhodesia—would consist of 50 farms, each with 100 acres. The Committee would select and screen immigrants, bring them from Europe, supply specialised technical assistance and also help in finance. If the pilot schemes turn out well, the project would be widened to bring in the Sabi-Lundi and Kafue Flats irrigation projects. Dr. Weizmann's report is being investigated by the Northern Rhodesian Government, and the Federal Government has called for further details before committing itself to accepting the proposals.

European Grass-seed Situation

DR HANS LEICHUM

BOTH increased area and yields have resulted in a 52% increase in European grass-seed production. It seems that prices influence the area sown for grass seed in a 3–4-year cycle, but demand remains relatively constant. The 1955–56 surplus is cheap in many European countries and there is a possibility of sales overseas.

Uncertain weather and varying prices contribute to the fact that production of forage seed fluctuates very considerably from year to year. This phenomenon is apparent in all European countries and in producing countries overseas, and the connection between price and production can be easily seen.

Factors influencing production

The results of an investigation published in 'Agricultural and Economic Dissertations on European Forage Seed Production in the Federal German Republic' have shown that high prices lead to larger areas being sown in the succeeding years, and the inverse holds true also. This 3–4-year cycle, of course, is affected by (*a*) political influences, (*b*) weather conditions, (*c*) attitude of producer etc. This is clearly shown in Fig. 1, in which the variation in the total cultivated area of the main European grass-seed-producing areas and the Danish grass-seed price index are shown. The totals shown (which include all species) are more striking than if a single species only was under review.

Similar conclusions may be drawn for New Zealand, Canada and the U.S.A.

TABLE 1
INCREASE, %, FOR PARTICULAR GRASS SPECIES IN 1955

Perennial ryegrass	36	Cocksfoot	25
Italian ryegrass	50	Meadow fescue	25
Timothy	24	Smooth-stalked meadow grass	50

TABLE 2
GRASS SEED AREA IN EUROPE[1] (THOUSANDS OF HA.)

Species	1949	1950	1951	1952	1953	1954	1955[2]
Perennial ryegrass	11	14	16	12	8	11	15
Italian ryegrass	5	4	5	5	4	4	6
Timothy[3]	17	18	22	19	20	17	21
Cocksfoot	9	11	14	13	12	12	15
Meadow fescue	6	7	8	8	6	8	10
Red fescue	2	2	3	5	6	6	5
Smooth-stalked meadow grass	0	0	1	1	1	2	3
Other species	3	3	5	4	4	5	7
Total	53	61	74	67	62	65	84
Average = 100	80	92	112	101	93	98	125
Price index[4]	145	151	101	80	136	209	93

[1]The table includes the most important producer countries: Sweden, Germany, Denmark, Netherlands, Great Britain.
[2]Preliminary figures.
[3]Timothy areas in Sweden 1949, 1950, 1952 average values.
[4]Average obtained from the price indexes of all species.

Increased sown area

The area sown for harvesting in 1955 was greatly increased (about 39% increase on the 1954 figure). This followed on medium prices for seed in 1953 and very high prices in 1954 (see Tables 1 and 2).

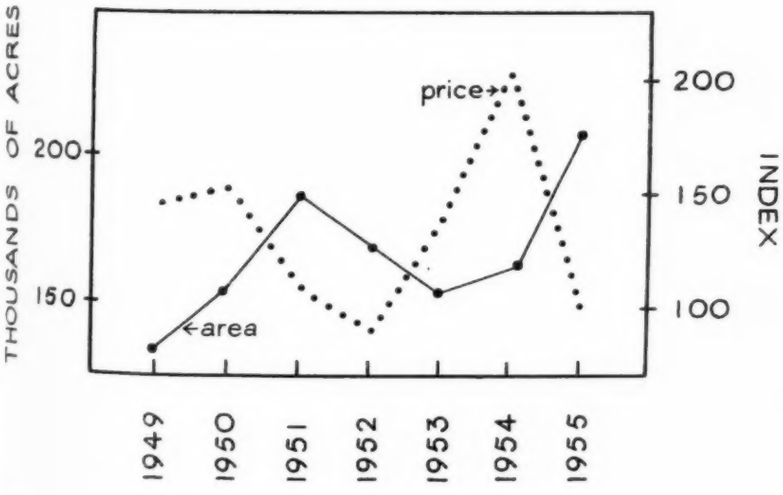

Fig. 1 Shows graphically total cultivated area in Europe and Danish price index

Yield increased 8%

The 1955 grass-seed yield was generally better than that of the previous year.

This is shown in the summary of Danish production (see Table 3). There were variations between species, *e.g.* timothy and smooth-stalked meadow grass exceeded the average yield by 30% and 20% respectively.

Other European countries also reported better yields.

Total production

Larger sown areas and higher yields resulted in a 52% total production increase. Smooth-stalked meadow grass showed the greatest increase with a production 2½ times greater than in 1954. The lowest increase was with timothy. Results are shown in Table 4.

However, at the present time only an average demand can be met—but during the 1955–56 season demand may possibly exceed that of the somewhat restricted 1954–55 season.

Supply of particular species

The supply position for particular

grass-seed species (current production plus reserve stocks) has increased by about 40,000 metric tons, or 55%, and thus exceeds the demand by 40,000 metric tons. The figures also show that normal demand could not be met in the 1954–55 season. Some seed was exported to the U.S.A. from Denmark.

Exports

Up to the end of December 1955 some 2,000 metric tons from the 1955–56 crop had already been exported from Europe to the U.S.A., and this figure was considerably increased by shipments in January and February 1956.

There is very little grass seed sent to other parts of the world.

TABLE 3

1955 GRASS-SEED HARVEST IN DENMARK (IN KG./HA.)

Species	1949–54	1954	1955[1]
Perennial ryegrass (early)	1,000	902	1,000
Perennial ryegrass (late)	797	760	850
Italian ryegrass	1,044	834	1,100
Timothy	398	305	500
Cocksfoot	657	687	675
Meadow fescue	690	700	725
Red fescue	642	481	700
Rough-stalked meadow grass	580	536	600
Smooth-stalked meadow grass	517	311	600
Average of relative yields	100	83	108

[1]Estimated.

However, the supply is still in excess of the average demand, but the demand for the 1955–56 crop may increase.

It can be seen from the tables that Denmark is the largest European grass-seed exporter. Also it seems remarkable that Sweden is able to meet the demand for almost all species.

The surpluses for particular species does vary. It is especially large for perennial ryegrass (although statistics for this crop are inaccurate) and cocksfoot. But certain reserves must be available at the end of the season.

TABLE 4

SEED SUPPLY SITUATION FOR SINGLE SPECIES, 1955–56

Species	*Average demand*	*Production, thousands of metric tons*		*Variation, %*	*Position in respect of particular countries, quantities in metric tons*		
		1954–55	1955–56		*Exporting countries*	*Self-sufficient countries*	*Importing countries*
Perennial ryegrass	32	27 (30)	47 (51)	+ 73	21,248 Denmark, England, North Ireland, Eire	Netherlands, Belgium, Sweden	5,995 FNS[2] East Germany, Austria, France, West Germany
Italian ryegrass	16	9 (11)	17 (19)	+ 77	4,300 Denmark, West Germany	Sweden, Netherlands, Belgium, France	3,357 England, Eire, East Germany, FNS, Austria
Timothy	16	14 (16)	16 (17)	+ 11	1,540 Sweden, Finland	Denmark	1,660 England, Eire, East Germany, Netherlands, France, Austria
Meadow fescue	4	5 (5)	7 (8)	+ 45	4,140 Denmark	West Germany, Sweden	1,346 Austria, England, Eire, Belgium, Italy, Netherlands, Poland, FNS, East Germany
Smooth-stalked meadow grass	0.8	0.6 (0.6)	1.6 (1.7)	+300	1,135 Denmark, West Germany		321 Belgium, Sweden, Eire, Netherlands, France, England, Austria, FNS, East Germany
Red fescue	2.1	2.4 (2.7)	3.2 (3.9)	+ 44	2,532 Denmark, Netherlands	Sweden	1,457 Belgium, FNS, Eire, France, Italy, Poland, Hungary, West Germany
Cocksfoot	5	8 (9)	10 (12)	+ 30	6,105 Denmark	Sweden, Netherlands	1,243 FNS, Eire, Italy, Poland, East Germany, England, West Germany, Austria, France
Total[3]	79	71 (79)	108 (120)	+ 55	46,544[4]		17,375[4]

[1]Calculated on the basis of actual figures.
[2]FNS = Finland, Norway, Switzerland.
[3]Includes other species not mentioned in table.
[4]Stocks unaltered.

Rice Mechanisation in Ceylon

G. R. W. DIAS, A.M.I.B.A.E.

The increase of rice production in Ceylon is a pressing problem. Ceylon has a population of more than 8 millions and her population is increasing at the rate of 200,000 every year; the increase is more than double the world average. Therefore it is imperative that her rice production be increased as much as possible in the shortest time. The use of tractor-powered machinery can play an important role in raising the economic power of the rice farmers in this country.

RICE is the staple diet of the people in Ceylon. The indigenous implements used on rice cultivation are either hand operated or animal operated. Mechanisation of rice cultivation is being carried out by introduced machinery, which often has been found to be not quite suitable for conditions in Ceylon. Some imported tractor-drawn implements have had to be modified to suit the local conditions.

Although the first tractors to work in Ceylon operated as far back as 1920, it was only during the second world war (in 1942), when some tractors were imported to the country to step up food production, that experiments were carried out on primary tillage operations in rice fields. The Agricultural Engineering Division of the Department of Agriculture, which was formed in 1945, demonstrated the economics of the use of tractors under proper management for primary tillage in rice cultivation by establishing six tractor units at suitable locations in the country. Following the success of these trials, the demand for tractor cultivation increased rapidly, especially in areas where there is a dearth of cattle and labour.

At present Ceylon has a little more than one million acres under rice cultivation. Of this acreage, about one-quarter could be regarded as suitable for mechanisation under the conditions prevalent in this country. The Government has encouraged the use of tractors by giving loans to co-operative societies to purchase tractors and by establishing tractor units at various locations in the country where a shortage of cattle and labour exists. The areas where mechanisation is mostly carried out fall within a belt ranging from sections in the Southern Province, Eastern Northern and North Central Provinces and portions of the Central and North-Western Provinces.

There are about 1,000 agricultural tractors in the country today and this figure includes the gift of nearly 200 tractors given by the Australian Government under the Colombo Plan.

Primary tillage

The trailed type of mouldboard plough was the first implement to be used for breaking up the soil in preparation for rice cultivation. On loamy soils with a fair amount of moisture this implement worked well, but the wear on the shares in certain areas where the soils are gritty was so considerable that in such areas about 10 acres only could be ploughed before the shares needed replacement. By hard-facing the shares with an alloy of nickel, chromium and cobalt it was possible to plough about 50 acres. On dry soils the performance of the mouldboard plough has been unsatisfactory. On most types of soils the disk plough works satisfactorily and is more popular than the mouldboard plough. The disk tiller used on sufficiently moist soils works well and is cheaper to use than either the disk plough or the mouldboard plough. On sandy soils free from weeds the tine tiller used twice does a very satisfactory job. When the soils are too dry and tough for the plough a light irrigation solves the problem.

As inversion of the soil is not necessary if puddling is to be done, a Rotovator or a tandem disk harrow could be used satisfactorily for primary tillage. A puddler, also known as a paddy harrow, attached to a tractor with extension wheels, used twice on rice fields at the Research Station, Mahailluppalame, as an experiment did a satisfactory preparatory tillage job. At Mahailluppalame, in the growing of unirrigated highland rice, it has been found satisfactory to use a broad sweep on the rice stubble and sow a crop of sunnhemp (L. *Crotalaria juncea*) and about a month later to use the disk tiller before seeding the rice.

A disk harrow followed by a seed drill on highland rice cultivation

Disk plough at work preparing the ground

Seeding and intercultivation

In 1944 experiments were carried out drilling seed in rows 1 ft. apart. The crop grew well in the early stages, but, owing to lack of intercultivating equipment at that time, the weeds could not be controlled sufficiently to obtain good yields. Seeding in rows 6 in. apart with subsequent irrigation has shown that weeds could be controlled to some extent. Broadcasting the seed and covering with a light disk harrow has been tried with some success. Many farmers appear to favour this method, as the action of the disk harrow in covering the seed destroys the small weeds which would otherwise compete with the crop.

Some success has been achieved by drilling seed in rows 1 ft. apart at the Research Station, Mahailluppalame, and by subsequent intercultivation with a rotary weeder. Trials are still being carried out with seeding and intercultivating equipment.

Harvesting, threshing etc.

Combines for harvesting, threshing and winnowing have been used on a small scale, but many difficulties were experienced in their use. The smallness of the size of checks in the rice fields, the unfavourable conditions in the field at the time of harvesting in most areas, unfavourable stand of the crop when plants lodge and the easy shattering of seeds of most varieties of rice are the main obstacles to be met with in the use of the combines in Ceylon. Even with the pick-up attachment the combine does not take in all the lodged rice plants under the conditions found in certain parts of the country. However, in the absence of suitable threshing and winnowing machinery, combines have been utilised with some success for stationary threshing and winnowing of rice. A few threshing and winnowing machines are being used satisfactorily in some parts of the country. Threshing by running the tractor on sheaves of rice is fairly common in areas where cattle are scarce for this purpose.

In certain parts of the country where the prevailing wind is weak a device made locally with a fan and parts of a bicycle, such as the chain, rear axle and cog wheel, and worked by hand, is used successfully for winnowing rice. It takes about 10 man-hours to winnow 40 bushels with this device.

Although the bullock cart is still the common mode of transporting rice from the threshing floor to the store, the tractor-drawn trailer and truck also play an important role in transporting rice from the threshing floors to the storehouses.

Problems of rice mechanisation

The tractor units run by the Government and the Co-operative Agricultural Production and Sales Societies undertake work for private parties at more or less standardised rates. In some cases tractor units have been run at a loss, owing mainly to heavy repair bills, lack of adequate supervision and the poor quality of the operators used to man the machines.

In other cases heavy repair bills have been encountered, owing to the damage caused to machinery used on areas newly developed, by using human labour. The presence of stumps and trees and their side roots have caused considerable damage to machinery. This lays stress on the necessity to use machinery for efficient land development work if tillage operations are to be mechanised thereafter.

The use of tractors with trailed implements in rice fields with small checks is very cumbersome and not common in the country. Tractors with mounted implements, where the tractor and the implement work as one integrated unit, are quite common now. The agricultural tractors used in Ceylon are of various makes and types and at the moment it is not possible to say which particular make or type is the most suitable for a particular locality or job.

Owing to the small-sized checks of rice fields in Ceylon, some imported machinery had to be adapted to suit local conditions. A study of seed drilling, intercultivation following seed drilling and the introduction of suitable harvesting, threshing and winnowing machinery appears to be necessary for successful mechanisation of rice in Ceylon. The introduction or breeding of rice varieties resistant to lodging and which do not shatter seeds easily is also necessary for the successful use of combines in Ceylon.

Conclusion

The total consumption of rice in Ceylon is about 925,000 tons per annum. At present about 439,000 tons of rice are imported every year. There is a population of over 8 millions in Ceylon and her multiplication rate of

One of the tractors gifted by the Australian Government under the Colombo Plan at work

200,000 per annum is said to be more than double the world's average. Even if the yield of the present acreage under rice can be doubled by improved methods of cultivation, there will not be sufficient rice in the country to feed 200,000 mouths every year at the present rate of increase in population.

While concentrating on improved methods of production to step up the yields, it appears essential to bring new irrigable land under rice to compensate for the low yields obtained at present and to keep pace with the increase in population. Man-power is available in Ceylon, but the land is limited in extent and there is a shortage of cattle for cultivation work in new land-development schemes. In such areas machinery should be used for development work and cultivation operations mechanised thereafter. Holdings should be made large, unlike the 'postage stamp' type of holdings existing in most parts of the country, so that machinery could be utilised efficiently and economically. As most of the farmers in Ceylon are too poor to purchase machinery, the Government or co-operative societies may have to own the machinery and undertake work on a custom basis, as is done in certain parts of the country at present. The use of tractor-powered agricultural machinery is bound to play an important role in elevating the economic power of the rice farmers in this country.

A local device for winnowing rice

Agriculture in Colombia

The International Bank for Reconstruction and Development has published proposals for changes in the agricultural system of Colombia, which are to go hand in hand with increased mechanisation, irrigation schemes and measures to increase food production. The proposals were made in a report of a World Bank advisory mission which visited Colombia last year at the request of the Government to help form a new agricultural policy.

The mission suggested, *inter alia*, that the Government should make a land survey to facilitate an expansion programme and that more tractors, fertilisers and modern crop-rotation methods be used. The mission estimated that 600 new tractors would be required every year for the next 10 years to achieve a satisfactory level of production and proposed that flood control and drainage schemes should be carried out to benefit an area of 400,000 ha. in the next 10 years. It estimated that about $10 million would be needed annually to carry out the 10-year programme.

Mobile Information Centres

As part of the drive towards increased agricultural productivity, 17 mobile information units are to be operated by the British Ministry of Agriculture, Fisheries and Food from provincial centres throughout the country.

Each unit consists of a rear projection daylight film installation mounted on a 16-ft. trailer, constructed for the Ministry by F. Stuart and Son (Shepperton) Ltd., of Chertsey, Surrey. Between film shows one side of the trailer can be opened up to form a canopied bookstall. Trailers were chosen in place of self-powered vehicles for reasons of economy and manoeuvrability.

The initial cost of the trailers has proved to be considerably less than that of comparable self-powered vehicles and the overall operating cost of the scheme is expected to be greatly reduced by the release of hauling units as soon as the trailers are parked in position and when the trailers are off the roads.

Reclamation of Eroded Lands

In Cyprus last year trials were carried out to test the possibility of the economic reclamation of eroded lands for agricultural or forestry crops. The Cyprus Department of Agriculture imported a powerful crawler tractor with ripping equipment capable of penetrating some of these lands to a depth of up to 30 in.

Since then several hundred acres have been broken up by ripping and contour banked in preparation for seeding or establishment of vines or the profitable carob trees. The reclamation work is financed out of a sum of £185,000 earmarked for land reclamation and development under the new development period in Cyprus.

Poplars for Matches

More than 100,000 poplar trees will be planted in Nyasaland this year to provide timber for the Federation of Rhodesia and Nyasaland's match-making industry. At present much timber for matchsticks has to be imported from Canada. In pursuit of this dollar-saving move, a match-manufacturing company's officer, Mr. A. C. Tingle, is now on a two months' tour of the Federation to interview farmers, planters and others who might be interested in growing trees for match production.

More Tobacco Per Acre

A warning to tobacco growers not to increase their acreages for next year's crop, but to try to improve the yield per acre instead, was given by the Chairman of the Rhodesia Tobacco Association, Mr. Evan Campbell. Mr. Campbell is a growers' representative on the Rhodesia Tobacco Marketing Board. He said he hoped next year's crop would be the same size as this year's. Every year in the past about 10% of the growers had gone out of business and were lost to the industry, but their places were always taken by new growers. This year their places would probably not be filled, but he hoped that increased yields would make up the difference. Demand would thus continue to be met. 'This year's sales have probably turned the corner and the improvement in quality during the past two weeks should continue'.

Progress Report on the French Agricultural Situation

RECENT months have confirmed the grave consequences of the February cold spell, during the course of which the area to the north of the Loire valley registered 24 to 25 days of frost. The situation was later aggravated by a lack of rain, which lasted to the end of May, rainfall becoming normal only in June.

The wheat crops have been reduced to 2,800,000 ha., against 4,500,000 ha. in 1955. The average yield is likely to be low.

Reseeded areas

The regions hit by the cold have been resown with secondary cereals—oats and, particularly, barley; some reseeding with oleaginous crops has been undertaken (Table 1). It is noteworthy to observe that the area sown to rice continues to increase at the expense of total vineyard area.

The poor results from wheat production (half that of the preceding year) has brought about several consequences : the deficit has prompted the *pouvoirs publics* to authorise the importation of 12 million quintals (1,200 million kg.) and, in order to make some compensation for decreased production, there has been an adjustment in the purchase price of wheat. The market situation has been further disturbed by the important requirements of the cattle-feed industry.

Fruit and vegetables

Fruit and vegetables lost on the food markets, but there were some remarkable deviations in price, particularly with out-of-season products. It is estimated that from April to August the decrease in production of home-grown fruits (strawberries, peaches, apricots, plums and pears) amounts to 800,000 to 900,000 quintals, or about 2 kg. per head of population. The part played by tropical and sub-tropical fruits, including bananas, has been more important than in former years. The changed price situation for fruits and vegetables can be seen in Table 2.

TABLE 1
AREA SOWN
(Millions of ha.)

	1 *May*, 1955	1 *May*, 1956
Winter cereals ..	5.8	2.3
Winter and spring cereals ..	8.3	7.7
Spring cereals ..	2.5	5.4
(of which barley)	(0.8)	(2)

TABLE 2
MARKET PRICE FOR FRUITS AND VEGETABLES
(as at July 1955 and July 1956, fr./kg.)

	July 1955	*July* 1956
Fruits:		
Apricots ..	120	240/260
Strawberries ..	110/140	250/300
Peaches ..	70/90	150/160
Bananas ..	105	35
Vegetables:		
Lettuce ..	55/95	80/30
Cauliflowers ..	55/72	100/35
Cabbage ..	18	50/25
Artichokes ..	90/72	110/90
Leeks	55/50	120/180

Stock position

The delay, caused by the cold spell, in turning stock out to pasture has led to a large increase in the use of prepared feeding-stuffs. The industry has at least doubled its activity over the corresponding period in 1955. The high price of *matières premières* (grains) has been increased and is much in excess of prices obtaining in other European countries.

This situation has led farmers to press for higher prices for meat and milk products. At the end of the recent milk strike the dairyman obtained, as a concession, a return to winter prices as from August and a price agreement for butter, which under certain conditions allows the importation of foreign butter.

Price index

The necessity of maintaining the agricultural revenue and, at the same time, of cutting the high cost of living has obliged the *pouvoirs publics* to cut the taxes on a certain number of products (groceries) as well as other industrial commodities (*e.g.* domestic gas) included in the national price index. On the other hand, some subsidised products, particularly prepared foods, are under close study. Such measures take on a permanent character and will eventually bring the cost of animal foods into limits comparable with other countries.

The exceptional circumstances that have prevailed recently in French agriculture have clearly shown that one sector of the agricultural market (vegetable production) is poorly organised and is not integrated with animal production. In a period when France ought to have been able to count on all her resources the agricultural set-up was found sadly lacking.

MAURICE LENGELLÉ

Agricultural Aviation Show, 1956

It has been announced that an Agricultural Aviation Show is to be held at Palmerston North Aerodrome, New Zealand, on 9 and 10 November this year. This is believed to be the first agricultural aviation show in the world and it will provide a unique opportunity for manufacturers of aircraft, equipment, instruments and products of value to farmers to display such goods to a world-wide audience.

Record crowds are expected: of people engaged in or interested in aviation, of farmers, grassland experts and members of the general public, who will attend from many overseas countries and from all parts of New Zealand.

Practical flying demonstrations by aerial work operators will show visitors the use of aircraft for fertilising, spraying, fence dropping, portage of farm supplies and the use of the helicopter for aerial farming. The programme will also include ground displays by aircraft operators, Royal New Zealand Air Force flying displays, films on aviation and agricultural topics and the application of radio to farm activities.

Aerial Attack on Serrated Tussock

An aerial attack is to be made on serrated tussock, which has taken possession of more than 2 million acres of farming land in the central and southern portions of New South Wales, Australia.

Pasture seed and fertiliser will be sprayed on the area from a plane based at Bathurst, centre of a rich agricultural area.

Soviet Collective Farming

Latest information emanating from the U.S.S.R. proves that the West is well informed about happenings behind the Iron Curtain regarding the political, military and industrial developments. It would be difficult, however, to say the same about our knowledge regarding agriculture. Except for rather vague statistical data and some technical information, occasional outbursts of complaints, abuses, intentions of reorganisation, etc. very little has seeped out in actual material and facts about agricultural developments in the U.S.S.R.

It is, therefore, quite an event that 'The History of a Soviet Collective Farm' by Fedor Belov* has been published. The author is a Russian refugee Army officer who, after being chairman and leader for a few years of a kolkoz farm in the Western Ukraine, has escaped to the West and is living at present in the U.S.A.

Any approach to a factual appreciation written by a political enemy of a régime, who is bound to be partial, has to be reviewed very carefully. However, stripping this book of all biases, it is a most valuable document of information, as it disperses at least partly the fog which has covered Soviet agriculture up to this date.

It is not easy to review this book, because there is very little practical evidence in hand which could be used for verification of the data and material included. However, circumstantial evidence can be found, as anyone who had the chance of visiting farms or villages of pre-World War I Russia, or who saw agriculture in Poland or Yugoslavia between the two world wars, can verify that the author has given us a true picture when describing the pre-revolutionary situation on the land, particularly when he writes about the peasant mentality and their attitude towards authorities and commands issued from distant unknown centres. This is the true and rather naive attitude in face of the terrible problems involved and the typical methods of circumvention through bribery, tricks and simple, but very effective, methods of deceit all show that the author's statements are an outcome of personal experience. Another proof of the author's truthfulness is given if one compares his description of the Russian kolkoz he was directing with the situation on the State co-operatives or farms of Yugoslavia. This has been, and is, the only Communist country to which any Western student has had free access since 1948 and therefore comparison is possible. Discounting the inherent natural and technical differences between the agriculture of the two countries, anybody who visited Yugoslav co-operative farms before 1951 would find a great deal of similarity. Though the new agricultural policy, which Yugoslavia introduced in 1952, has transformed their co-operative farming, much similarity can be found by anyone who had an intimate insight into Yugoslavia's co-operatives and State farms, especially regarding the mentality of agricultural authorities, farm managers and, above all, of the Yugoslav peasants.

Kolkoz structure

Following a very comprehensive picture of agricultural conditions on his farm before the revolution and giving a short survey of the different stages of development during the early years of Soviet régime, the author describes all details of structure, planning, organisation, labour and machinery, implements, field work and cropping, animal husbandry, rural housing and economy of the private household. It would be of no avail to go into details here, as conditions in the U.S.S.R. are so different from those in the West that all comparison would be misleading. However, the fact that on a farm of 2,300 acres of arable land the total yearly production of cereals has not been more than 1,400 tons (28,000 cwt.) and 2,200 tons (44,000 cwt.) of sugar-beet (these being main crops), and bearing in mind that this farm stands on one of the most fertile soils of European Russia, is rather depressing. Yields of 15 cwt. per acre of wheat are anything but spectacular.

The structure of a collective farm is about the same as that of any large-scale farm in a Western country and it should be run on profit basis. The surplus income after the deduction of costs, taxes, depreciation fund etc., and some special payments, should be shared out between all workers in accordance with the number of labour units they can show during the year.

The kolkoz is a so-called socialist property. It includes all possessions which the peasants brought with them when they joined it, willingly or unwillingly. Land, buildings, machinery, implements, livestock have all been turned into kolkoz property. The private plots or garden strips which are allocated to the members, as well as their houses, are also kolkoz property. About 17% of the acreage of the kolkoz had been allocated for private plots. The author admits that these give a much higher yield per acre than the fields of the kolkoz because they are looked after with great care and individual handling is 'paying off'. The average livestock and private property of members consists of a cow, one or two pigs and some poultry per family, and these are the iron reserves on which kolkoz members have to live if, as it frequently happens, the return for their labour on the farm is insufficient. The unit for measuring labour is the so-called 'labour day' and the minimum has been fixed at 130 days per member per annum. However, in this particular kolkoz the average had been 275 days. This means that men worked 250–300, women 150–180 and youngsters 50–60 labour days per year. Wherever possible piece work was introduced. The author's figures of the actual payments for labour units do not reveal much, as all prices and foodstuffs which were used for payments are quoted at such inflated currency terms that it is difficult to give their equivalents in £ *s. d.* However, the total value is far from being sufficient, as heavy taxes and compulsory deliveries of crops grown on private plots have to be taken into account.

The kolkoz paid to a normal family earning about 500 labour units per year approximately 500 kg. (10 cwt.) of grain—wheat, rye, corn, barley—500 kg. (10 cwt.) of potatoes, 1,500 kg. (30 cwt.) of straw and 400–500 roubles, which would mean, expressed in the value of consumer goods, about £12–

* 'The History of a Soviet Collective Farm' by Fedor Belov. Pp. xiii + 237, including appendixes. London: Routledge and Kegan Paul. 1956. 21s.

15 in cash per year. The private plot might yield about a further 300 kg. (6 cwt.) of grain and 1,500 kg. (30 cwt.) of potatoes, plus other vegetables. Milk, or any animal products, including eggs, has partly to be delivered at very low prices to the State. However, some remain for home consumption and, if possible, for exchange against consumer goods.

To cover taxes the household had to sell from its private plot 150–200 kg. (3–4 cwt.) of grain and 200–300 kg. (4–6 cwt.) of potatoes and most of the sugar allocation which peasants receive for their work on the sugar-beet fields. For most of the members the above net quantity of grain lasts not longer than about seven to eight months, so the family had to live for the rest of the year on potatoes and other vegetables. Meat consumption was inadequate, about 10 kg. (22 lb.) per annum, and fats not more than 15–30 kg. (33–44 lb.), which is very low indeed under the climatic conditions prevailing there.

Basic food

Basic food consisted of bread, cabbage soup, potatoes, other vegetables and fruit. Living standards are very low and, although it can be assumed that in the last years, especially since Stalin's death, the situation has improved, it is still very far from being satisfactory, even in comparison with the average Russian standards, which are very low.

Supervision

The real nightmare of the system is its extremely complicated line of command with parallel organisations: one directed by technicians, another by the Party, plus the third by the ' Inspection Committee '. The leader of the kolkoz is its chairman, who acts with the board of managers. This is the elected body and the executive of the General Meeting of members, which is the ultimate authority inside the kolkoz. This elects also the above-mentioned ' Inspection Committee ' under a separate chairman. This committee is in charge of controls, checking expenditure, accounts, deliveries and has to look after the stand of buildings, machines etc. This is a very heavy responsibility and the members of the committee therefore have to be confirmed by the district Soviet Administration. Accountants and other experts, warehousemen, agronomists, sugar-beet experts etc. are generally outside employees and paid for the part-time job by the kolkoz. The actual manual work itself is done under the leadership of the N.C.O.s of the kolkoz, the so-called 'brigadiers', and members are organised in brigades of about 100 labourers, and these again in squads consisting of 16 to 18 labourers, mostly women.

One of the surprising facts which is disclosed in the book and is confirmed by recent visitors is the preponderance of female labour on the farms. Undoubtedly this is partly the aftermath of the wartime labour situation and we suppose that since 1949, when the book was closed, the percentage of men in the farm labour force has increased. However, if the living standards on the farm have not improved since, and if, as anticipated, they are much better in industry, and the need for manpower in industry is still not satisfied, not much change can be surmised.

Machinery

The kolkozes had their own implements and simple, mostly animal-drawn, machinery, but they had to rely on the machine tractor stations for more important mechanised work. They had no tractors, harvesters, beet harvesters, mechanical hoeing equipment or threshers of their own—all these were supplied by the machine tractor stations and serviced by them against heavy fees, generally in kind. Agronomists were also supplied by the machine tractor stations and this system meant just another pretext for State control and interference. All internal criss-cross lines of checks and commands would not matter so much as the fact that all planning and instructions, which go right into the smallest details, are given by remote control, and issued by authorities, who are working on purely theoretical and administrative lines. A further trouble lies in the fact that these are directed by Party men or politicians, if you like to call them as such, instead of technicians, who are not interested in any human aspect of agriculture and do not accept that any rules of nature that do not comply with their plan should be respected.

The amount of red tape with which the unfortunate chairman of a kolkoz has to cope is tremendous. The only possibility of survival was to develop a line of resistance quite traditional in pre-revolution Russia, but somewhat surprising in the enlightened years of Communism—the immoral but highly successful method of bribery and corruption. The writer schedules a comprehensive list of bribes that had to be paid during his régime. There can be no doubt of its genuineness, as these bribes are mostly in kind—farm products etc. traditionally used for such purpose—and sometimes quite ridiculously small; still, they were necessary to keep officials in a kindly mood and to secure their goodwill.

Controls

If we look for the reason why this elaborate system of trials and checks had to be established the explanation is that it was of vital importance to the State that delivery quotas should be fulfilled and, as the disgruntled peasants sabotaged production and deliveries, they had to be constantly supervised. The misery and degradation of the bulk of the kolkoz members grew steadily and this, coupled with the lack of any sensible incentives, led to their complete disinterest in the improvement of production. Controls had to be strengthened all along, but with the growth of controls the resistance did not diminish and members tried to evade, as far as possible, work on and for the kolkoz. They were led to corruption and theft and were induced to concentrate their work on the small private plot which gave at least some basic foundation for living. There they had to fight only against the adversities of nature, which seemed far less merciless than the officials and the red tape of the system.

Overhaul required

A number of years have gone by since this book was written; Stalin's rule is broken and after reading this human document it can be fully appreciated why Mr. Kruschev had to concentrate on the reorganisation of the agricultural policy, why this has been his major interest and why it was necessary to alleviate the burden of the peasant. New incentives had to be given and these had to be extended to products coming from the private plot —this anathema of Marx's agricultural policy. It seems that up to this date

Continued at foot of next column

Man and the Land

This book* is the second contribution by Prof. Stamp to the New Naturalist Library. His first volume, 'Britain's Structure and Scenery', described how characteristic features of the landscape were evolved—the influence of structure of scenery. In this second volume Prof. Stamp is primarily concerned with the activities of man and with the finger prints left by him on the geological record. The editors of the series say in the preface that 'if asked his business, Dudley Stamp would probably say that it was geography and that ecology was his recreation'. If this is true, the book represents the results of the author's recreation and, indeed, the vigour of the writing and the richness of illustration do suggest a more than ordinary enjoyment from the preparation of a book.

Man and his works are anathema to many ecologists, who see as their vocation the study and preservation of 'natural' flora and fauna. This narrow outlook leads such ecologists into searches for 'undisturbed' areas, usually minute pockets in the fabric of the countryside. To such naturalists the sheep and cattle, farm crops and introduced weeds are of little interest. Prof. Stamp takes a wider view: it seems that to him man, rather than being an intruder into a fascinating environment, is the most exciting part of that environment.

The first nine chapters are concerned with the history of the British landscape, with a brief note on prehistory. The author tries to describe the type of farming practised by the pre-Roman tribes, the Romans, the Anglo-Saxons and under the influence of the Normans. The situation at the time of 'Domesday Book' is summarised and then the fascinating developments, such as enclosure and stock improvement, leading to the usage of the present day. He describes the traces that have been left by the early farmers and there are excellent illustrations in the form of aerial photographs of the square 'Celtic' fields, the curious lynchets, which seem to have derived from contour ploughing, and Anglo-Saxon strips.

More than half of the book is taken up with a discussion of crops, stock and forest trees in Britain.

Under the heading 'Guests: Invited and Uninvited' Prof. Stamp describes the spread of alien weeds and animal pests. This is a valuable chapter, collecting together data that are not often seen assembled and in perspective. Perhaps the editors might consider devoting a whole volume to this subject some time.

The colour illustrations are disappointing, sometimes through faulty reproduction, sometimes through poor choice of material. A colour picture of a man shooting coypu rats does not figure the coypu and might just as well have been entitled 'man shooting otter, moorhen or escaped tiger'. In contrast the black and white illustrations are excellent, especially the photographs from the air. Perhaps the editors have become tied to the view that colour illustration is always best (even to illustrate a black cow): this volume proves the contrary.

The first volume showed Prof. Stamp as geographer and geologist: this volume proves him to be ecologist, natural historian, archaeologist, agronomist and historian. The New Naturalist series is fortunate to have a contributor so erudite and with so smooth a pen.

J. L. HARPER

*By L. Dudley Stamp. Pp. 272. London: Collins, Sons and Co. Ltd. 1955. 25*s*.

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not much success has been achieved. This is, in all probability, because the malady of the system is too deeply rooted and cannot be cured by superficial treatment. A lot of rethinking has to be done, and it seems improbable that without a complete overhaul based on a practical approach to the human aspects in agriculture and to the acceptance of the fact that nature should replace the Marxist textbook much could be achieved. Planning and remote controls cannot replace the human factor in the agricultural problem.

C. DE FELLNER

WAIFOR Quarterly Report

We have received a copy of the quarterly progress report of the West African Institute for Oil Palm Research. Summaries are provided on the work of all the research divisions.

*

Farm Tractor Lubrication

This booklet by C. C. Wakefield and Co. Ltd. has now been extensively revised and rewritten to bring it fully up to date. The new edition consists of 72 illustrated pages dealing with every aspect of the lubrication of farm tractors, both spark ignition and diesel.

*

Crop Protection Products Approval Scheme

The British Ministry of Agriculture has published this year's list of approved chemicals under the Crop Protection Approval Scheme in a new and improved form. The changes made should enable the user to identify more easily the chemical which will control the disease, pest or weed threatening a crop. The Crop Protection Products Approval Scheme is a voluntary scheme for the official approval of proprietary chemical products for the control of plant pests and diseases and for the destruction of weeds. A standard official mark appears on the container of any approved product.

*

'Embarfume'

May and Baker Ltd. have published a technical booklet on 'Embarfume' methyl bromide. It provides much interesting information on the uses and hazards of this material.

*

European Grassland Conference

This book contains papers read before some 200 European agriculturists, research workers and farmers from 17 countries at an international conference convened to study European grassland problems. The publication comprises the summary of the general conclusions and recommendations and deals, *inter alia*, with the ecology and physiology of fodder plants, cytology, genetics and selection of fodder plants, the production and distribution of seeds, and the production, harvesting and conservation of forage by machinery. Published in Paris by OEEC. U.S. $1.50, 10*s*. 0*d*., 500 Fr. fr.

Scrub Cutting

SCRUB cutting involves a number of difficulties. Time is easily consumed. Yet speed spells economy of labour costs. How can one carry out this often necessary task most efficiently?

There are many different kinds of undergrowth. Ordinary weeds and grass, and even bracken, may involve nothing more than hard work, though it is harder work than it looks. Heather is stringy and tough. In some situations it can be burnt, but the fire destroys the humus in the ground and renders the soil barren. Bramble is nasty to handle. Hawthorn is worse. Gorse, perhaps, is worst of all. And what of the young saplings that have probably sown themselves during the years of neglect that lie behind this problem of the land?

On open even ground all these difficulties might yield to the expenditure of sufficient energy. But inaccessible situations and rough surfaces call, in addition, for patience; and this, essentially, is time and money.

The condition of the ground aggravates the problem if it involves a long accumulation of rubbish. Bricks and flints and broken bottles, common in such situations, are none too kind to a cutting edge. Jagged tins and hidden wires and discarded machinery parts add to the difficulties of the job. They can be a danger to the worker. They certainly menace whatever tool he uses.

After considering the wide variety of undergrowth with which he had often to cope, the uneven nature of the ground generally, the frequent inaccessibility of the terrain, the amount of obstructions likely to be met, man devised the sickle and the scythe. For centuries they were the only really effective cutting instruments in the circumstances involved. After all, they were designed and developed for the job in the light of a long historical experience, so it can be little wonder that man gave his vote to them from time immemorial.

But in our changing world nothing stays still and recently labour costs have soared. So, in scrub cutting as elsewhere, machines have been called in to reduce the need for hand work. They make for economies in time and therefore reduce costs.

There are, however, machines and machines.

Requirements

We need a machine that is capable of attacking all types of undergrowth. We need a machine that will work at one constant adjustment for many little differences in the demands made on it. For working on rough ground we need something robust. Equally, however, we must have something light in weight and easy to manoeuvre.

Lightness, incidentally, will reduce the initial cost and the subsequent running costs. On the other hand, we must avoid anything like a toy, for we want a machine that will not clog or jam, lest we lose the time and money we had hoped to save.

Since the man on the job can see what he is doing better in winter than in leafy summer, since we then usually have more time for this kind of task, and since, anyway, we often cannot choose our timing, but must operate at once, whenever that is, we need a machine that will work as well in the cold of winter as in the warmth of summer.

A machine for the job

All these essential factors have been considered and incorporated by the engineers and technicians responsible for the design of the Four Seasons scrubcutter.

Essentially the machine is a mechanised sickle.

At bottom the cutting device is a solid steel disk. This rotates at ground level in a horizontal plane. It thus cuts off all forms of vegetation to a flush surface. It also, as it does this, incidentally levels out molehills and anthills and all such minor protuberances.

Still more particularly, the cutters are two sturdy triangular knives attached to the circumference of the disk. These, as they rotate, reproduce the sweeping curvilinear cutting motion of the common hand sickle.

Because they are placed diametrically opposite each other they cannot jam or clog.

And because there are only two of them they attain an adequate speed for a clean, powerful cut. Roughly speaking, the maximum requirement of a sickle is to cut off a young sapling of about 2 in. in diameter. This the Four Seasons scrubcutter will snick off as it goes.

In use other tasks may be allotted to it. Thus to spread the products of a first cutting all that is required is a to-and-fro movement of the machine, after which the material may be left to mulch a new planting.

Of solid steel construction, the machine is robust. Yet it is light in weight and easy to manipulate. Nevertheless, it is immune from damage by obdurate obstructions accidentally encountered, for in such extreme cases the belt is thrown off to remove the drive to the cutter head.

The drive comes from a Villiers two-stroke engine. This is easy to operate and easy to maintain. It is proverbially reliable and runs at low cost.

Malayan Forest Improvement

The Malayan Forestry Department states that, although the Malayan timber industry is the fourth largest industry in the country, the full potential wealth of the forests has yet to be realised. The Department is carrying out extensive experiments to increase timber production. A large area of forest has already been regenerated and the Department expects that the yield from these new crops will be from three to four times the yield from existing forests. At present about 10 to 15 tons of timber per acre are extracted from unimproved natural forests, says a report in the *Malayan Forester*.

Tobacco Research

The Australian Federal Minister for Primary Industry, Mr. McMahon, said recently that tobacco research and advisory services in Australia are to be greatly extended.

The proposals provide for a capital expenditure of £A153,000, of which £A108,000 will be spent in Queensland by the Commonwealth Scientific and Industrial Research Organisation and the Queensland Government. Annual maintenance costs are estimated at £A71,000, of which £A53,000 will be required for Queensland.

MACHINERY AND EQUIPMENT

Ultrasonic Cleaning

As in large repair shops, ultrasonics are also used by the agricultural machine industry in order to free components from dirt and manufacturing residues before galvanising and other surface treatment. The effectiveness of ultrasonic cleaning machines is due to the fact that ultrasonic energy is sent into the cleaning fluid. The vibrations, between 20,000 and 500,000 cycles per sec., drag all dirt particles from the components into the cleaning fluid. The cleaning process reaches points which cannot be thoroughly cleaned by other methods. Hundreds of items can be cleaned simultaneously and within a few minutes.

The apparatus consists of the generator, in which the ultrasonic energy is produced by high-frequency oscillation, and of the washing machine itself. The latter contains four tubs of 25 to 50 litres in capacity, two of which are exposed to the ultrasonic treatment, and the other two serve for rinsing and drying. The procedure is so simple that even unskilled men can handle the machine. Apart from the water, many other liquids, such as alcohol, gasoline and petroleum, can be used. Being by far the most effective cleaning method, ultrasonic cleansing has made a place for itself in Germany, not only in automobile and machine industries, but also in the field of optics, fine mechanics and electrical engineering.

This information was digested from *Landtechnik*, 1955, (No. 18), p. 672, and was made available by *E.P.A. Technical Digest*, No 560.

Reader Service

For further information on any item of machinery or equipment reviewed in this section please write to:

Reader Service,
WORLD CROPS,
Stratford House,
Eden Street, London N.W.1,
England

Tractor Trailers

Carrying the mark ' Saicar ' is the Spanish-built, heavy-duty agricultural trailer. It is manufactured by S.A. Accesorios Industriales and combines maximum sturdiness with minimum weight. The trailer is specially reinforced and protected; with its large capacity it solves all transport problems with manure, grain, straw, lucerne, beet, gravel, building materials etc.

Specifications

The suspension is of oil-tempered, special steel springs.

A 5-cwt. sack lifter for use with tractors with hydraulic lift

New-type hypochlorite package for the dairy farmer

The drawbar is provided with a ring for attaching to the tractor, and a special shock-absorber spring is incorporated in the head of the drawbar.

Turntable—triple action, without central pivot.

Bodywork — reinforced, removable sides with forged locks and hinges.

Length 4 m., width 2 m., height of platform from ground 1.05 m., capacity 6,000 kg.

Sack Lifter

With a lifting capacity of 5 cwt., a useful sack lifter is now being produced in Britain. It has been designed for tractors with hydraulic lift and is thus suitable for Ferguson, Fordson Major, David Brown ' Cropmaster ', Nuffield and International tractors. It is fitted to the three-point linkage and can be attached in a few moments. The swivelling platform makes the lifter versatile and capable of handling sacks, oil barrels etc. in a confined space.

New Package for Hypochlorite

Dairy farmers particularly will welcome the ' Safety-Pak ', for a British firm manufacturing dairy cleansers are now able to market sodium hypochlorite in non-returnable, laminated polyvinyl chloride packages. The PVC inner pack is supported by an outer case of ' double-double ' board, which is precisely shaped to fit the ' Pak '. Sodium hypochlorite, which is affected by light and heat, is adequately pro-

This American forage harvester has a completely offset hitch and a capacity of approximately 20 tons per hour. It is possible to cut efficiently and to load a variety of grass crops for silage or green feeding.

tected by the ' Safety-Pak ' and, it is claimed, it will retain its efficiency far better than when a carboy is used for storage and transport.

The new container pours well and the PVC ' Pak ' can be put to a variety of uses when all the chemical has been used.

Independent p.t.-o.

The Nuffield ' Universal ' tractor (manufactured in England by Nuffield Exports Ltd.), in all its models, can now be supplied with independent p.t.-o., run directly from the engine, which will work at a constant speed regardless of the tractor's movement. A second clutch enables the p.t.-o. shaft and, if necessary, the hydraulic pump to operate whether the tractor clutch is in engagement or not, thus reducing the extra time, cost and the lack of efficiency due to engine duplication.

With this new direct power the performance with such implements as combine, baler, mower, potato-digger, hedge-cutter, sprayer etc. is claimed to be vastly improved, and in most cases the need for implements driven by separate engines is eliminated.

Uninterrupted operation

Quick clearance of tufted or bunched crops and difficult field operations may be accomplished under full power by simply depressing the tractor clutch pedal. Forward movement of the tractor is reduced or halted, but the implement will continue running without pause. After clearance, merely releasing the pedal starts the tractor forward again. Furthermore, the tractor may be stopped, started or shifted into any gear without interruption of the p.t.-o. operation, and whenever the engine is running the independent p.t.-o. will keep the driven implement at correct operating speed.

When an implement meets with a particularly heavy crop it may become jammed. With an independent p.t.-o. it is only necessary to slacken the speed of the tractor, or stop it, by using the normal clutch pedal. The independent p.t.-o. continues to revolve, thus allowing the implement to clear itself.

The twin clutches are built as a unit and secured to the engine flywheel in the normal way. The clutches are actuated by independent throw-out forks in conjunction with ball thrust bearings. The tractor transmission clutch is controlled externally by an orthodox clutch pedal and the p.t.-o. clutch by a hand control lever on the nearside, convenient to the operator's left hand. Power from the tractor transmission clutch is transmitted by solid splined shaft to the primary shaft of the gearbox; the drive from the p.t.-o. clutch is by hollow splined shaft to flanged dog couplings, thence to a hollow spur pinion driving a gear secured to an intermediate p.t.-o. shaft. This shaft extends to the rear of the main gearbox and runs in a hollow layshaft. Engagement of this p.t.-o. with the output shaft at the rear of the tractor is effected by the normal p.t.-o. and hydraulic lever at the rear in the usual way.

The design of this new feature is such that removal from the tractor of the clutch unit and its driven components can be accomplished (as on all Nuffield tractors) without disturbing the engine or transmission casing.

The independent p.t.-o. can be supplied only as an ' optional extra ' on new tractors and conversion kits will not be available.

Forage Harvester

A newly designed American forage harvester with a completely offset hitch was announced recently. With a capacity of 15–25 tons per hour this machine cuts a 58-in. swath with 28 swinging knives, which rotate on a central shaft. The tractor never passes over the crop being cut.

With the one main working part (shaft with hammer knives) and without auger or blower it is possible to cut quickly and efficiently, chop and load a variety of grass crops for silage or green feeding.

The wheels on the rear of this new machine are adjustable to accommodate all grass and row crops. The new sharp cutter knives offer a finer cut if desired. Hydraulic or manual control is optional and the spout is adjustable for delivery height of 9 ft. 2 in. rear or 10 ft. 4 in. side delivery.

The standard offset hitch is adjustable for hay crops, row crops or transport position. Wheels never trample the crop being harvested. The caster-wheel attachment is available for use alongside trucks. With motor mount, the chopper can be pulled with the same truck being loaded.

This machine is the basic unit for the new corn head attachment soon to be put on the market by the same firm.

Loading Shovels

New loading shovels, of advanced design and capabilities, are now immediately available from W. E. Bray and Co. Ltd., a British manufacturing firm.

By extensive research and the full utilisation of experience this company have now produced shovels to make greater than ever contributions to earth-moving and materials handling.

Designed to embody all the proven Bray features, these latest machines, by their power, constructional strength, ease of operation and speed of working, give a fresh emphasis to the potential of loading shovels in all spheres of industry.

Dualoader DL35

This ' Dualoader ' DL35, with its dual capabilities of front-end and overhead loading, employs as standard a ¾-cu.-yd. bucket and has a safe working load of 20 cwt.

All of the new advantageous features are built into the DL35, including those of external design, strength of construction and efficiency of the hydraulic units. Full power crowd and the positive control of the bucket is, of course, a major advantage.

The main boom of the DL35 pivots on a centrally positioned A-frame constructed so that there is no requirement for modification or adjustment when front or overhead loading. The double-acting, 5-in.-dia. main jacks with chromium-plated piston rods incorporate an hydraulic shock absorber.

In many applications the ' Dualoader ' is able to improve greatly upon the time cycle of a front-end loader.

The importance of stability in an overhead loader has been recognised at all stages of manufacture of the ' Dualoader ' 35. As additional ballasting the front and rear inner tubes are 100% filled with a solution of calcium chloride—this solution being so constituted to prevent freezing in the coldest of local conditions.

For work in confined conditions where manoeuvrability is restricted, for increased tonnage and reduced wear and tear the ' Dualoader ' has all the advantages of an overhead loader which is, in addition, designed to meet the requirements of front-end loading.

The ' Dualoader's ' multiplicity of purpose is further increased by the availability of a bulldozer blade, a snow plough, a crane attachment and a fork lift, both of which are supplied with an audible and visual warning device and digger teeth for the bucket.

The ' Dualoader ' DL35. With reduced need for manoeuvring there is a lessening of wear on the engine, gearbox and steering mechanism.

Pressure Relief Valve

Spraying Systems Co. have announced their new 6815 pressure relief valve for use on farm spraying equipment of all types. Because of the large internal valve area, full flow from supply lines up to ¾ in. at normal pressures can be handled. With its special inner rib construction of the valve body, full flow of liquid around the shut-off piston takes place, preventing the ' salting out ' of such chemicals as fertiliser solutions. As a result, plugging and clogging of the valve is prevented. The piston assembly is mounted within the valve chamber; no gaskets are used as a part of the piston assembly itself that might swell in the presence of chemicals and retard piston action.

This pressure-relief valve has a double spring. The high-tension spring operates at high pressures and the low-tension spring gives accurate control at lower pressures

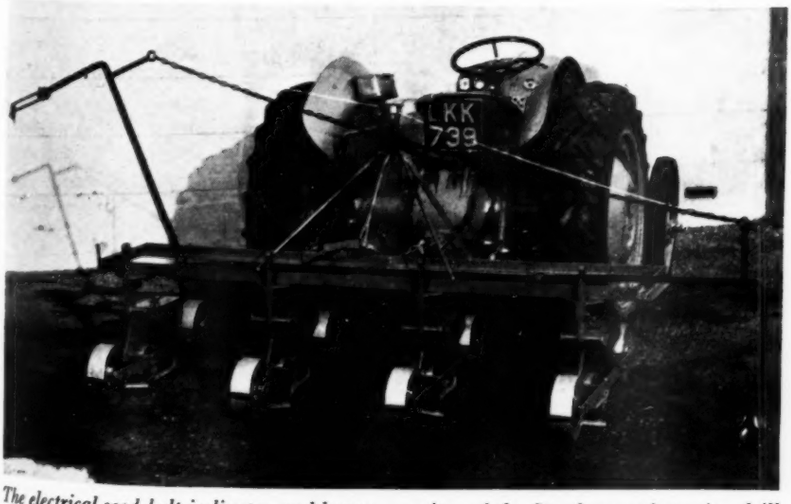
Another important part of this valve design is the double spring. The higher tension spring is operative at higher pressures; the second lower tension spring gives accurate control at lower pressures. No. 6815 pressure relief valves are supplied in brass or aluminium, with stainless steel stem and springs.

Seed-spacing Drill

The British Stanhay seed-spacing drill is designed to fit to standard toolbar frames, but, to avoid the necessity of stripping off the existing tools and reassembling, the manufacturers have produced a light frame with markers to carry the drills and fit to the tractor power-lift linkage.

Row-width adjustment is easy and simple, as the frame has a series of holes at 1-in. spacings. The standard frame is 7 ft. wide, but frames up to 9 ft. wide can be supplied to suit individual requirements.

The electrical seed-belt indicator and hopper monitor is a compact set of equipment operated from the tractor battery. It is supplied complete with wiring loom and a totally enclosed control panel that is fixed in front of the tractor driver. There is a warning light controlling each drill unit which tells the driver immediately should the



The electrical seed-belt indicator and hopper monitor of the Stanhay seed-spacing drill is a compact piece of equipment operated from the tractor battery

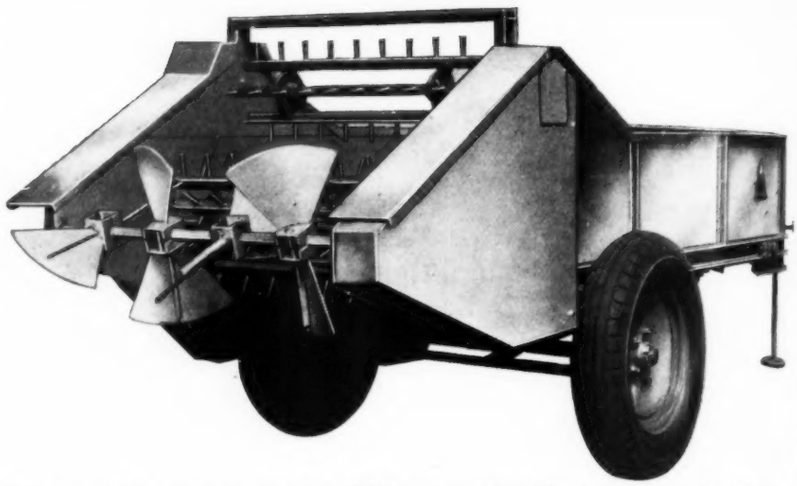
seed belt stop turning for any reason and also when the hoppers need topping up with seed. By using this equipment it is not necessary to have a man behind the drill.

Manure Spreader

Designed and manufactured in Britain is the new ' Mount ' manure spreader. It is a power-drive model and has been designed for the heaviest work under conditions which make a land-wheel drive impracticable. The frame is of exceptional strength and will safely carry up to a 3-ton load.

Specifications

Overall length, 17 ft.; width, 5 ft. 10 in.; weight, 17 cwt. Phosphor bronze bearings with adequate greasing facilities throughout. Heavy-gauge aluminium sides for anti-corrosion. Fabricated steel spreader blades. Heavy-duty, malleable iron driving chains. Main axle, 2-in. diameter. 600/19 pneumatic tyres. Safety device for transmission in case of blockage. All sizes of couplings available.



The power-drive manure spreader. With an exceptionally strong frame it will carry loads up to 3 tons

Direct-connected Plough

Deep digging or ploughing, while usually done on flat land or big holdings with powerful digger-ploughs drawn by caterpillar tractors, becomes more difficult on hilly land and on flat land, too, if the holding is small, when numerous manoeuvres have to be made in a restricted space.

The size and weight of the heavy tractor-plough unit are so great that manoeuvres are slower and more difficult, thus considerably lowering the surface worked hourly.

An Italian agricultural machinery company has now developed a heavy type of direct-connected plough which can be employed with ordinary types of heavy tractors through a robust mechanical coupling giving well-balanced transmission of the tractive effort to the two tractor tracks. A suitable steering system allows the plough to be shifted sufficiently in respect of the tractor.

After use the plough is raised by a pulley unit driven by the tractor winch.

Design

The direct-connected plough is constructionally designed like an ordinary plough. It consists of a straight beam composed of two rigidly trussed iron bars, the end of which is designed for through bolting the frame which carries the share and mouldboard, while the other has a hollow support for coupling the plough to the tractor.

Halfway along the side of the beam a swivel coupling connects the draw-bar, which is coupled at the other end to the tractor by another articulated joint. The plough and tractor are mechanically connected at three points, *i.e.* at the beam coupling, at the draw-bar coupling and at the steering stop bar coupling.

The beam is coupled to the plough by fixing the end support of the beam on a tubular shaft which is supported by two special brackets fixed at the rear of the tractor.

Steering

The steering pivot is also on this tubular shaft, being inserted in an eye located on the end support of the beam, where it can slide to allow the plough to shift sufficiently in respect of the tractor.

The plough draw-bar is coupled by fixing its swivel tip in a housing provided at the rear of the tractor. This coupling is designed so that the tractive effort bears wholly on the bar, the beam being entirely relieved of the drawing action, and the effort itself is equally distributed over the two tractor tracks.

The steering stop bar, which restricts the steering shift of the tractor in respect of the plough, is also coupled at the rear of the tractor, opposite the beam. The bar tip coupled to the tractor is articulated so that the bar can rotate horizontally. As stated, the other end of the bar slides in a special support on the beam.

Performance

The actual performance obtainable from the new type of direct-connected plough and a cost comparison between this and the trailer type for breaking up land have been ascertained practically in a series of trials made on flat land with hard, clayey soil, and on hillsides with an average gradient of 6% with varying types of soil, both gravelly and clayey.

During these trials the stress on the plough draw-bar was also measured, replacing the latter by a spring-type dynamometer provided with special hooks.

For the trials comparison was made between a 2,900-kg. direct-connected plough (including the coupling unit for connection to the tractor), used with a heavy tractor, and a 4,000-kg. trailer plough. With the latter the land was less deeply dug, the hourly worked surface was 8% less and the hourly quantity of soil moved 26% less than with the direct-connected plough.

The unit cost of digging per cubic metre of earth moved with the direct-connected plough, therefore, was 15% less for operation on flat land and 8% less for operation on hilly ground as compared with the unit cost using a trailer plough.

This information was digested from *Macchine e Motori Agricoli*, 1955, 13, 51, and was provided by *E.P.A. Technical Digest* No. 586 (2).

WORLD CROP REPORTS

PERU

Cotton

It is now considered that the present year's crop will be very good, reaching probably a total of around 2,400,000 quintals or very near that of the record crop of 1954. The crop is very good in the central valleys and in Piura, whereas in Canete about half has been lost due to pests.

Rice

The rice harvest, which was commenced towards the end of June, is good and is expected to yield about 1,691,000 fanegas (1 fanega = 1.6 bushels), as compared with 1,630,000 fanegas last season. The producers hope this year to place a part of the crop abroad, particularly in Japan.

PARAGUAY

Cotton

Floods ruined some areas and a drop of 6,000 tons in 1955 reduces the 1956 estimate to 30,000 tons for a weak export market. To improve future quality the Government wish to import 300 tons of ' Delta Pine 15 ' seeds from the U.S.A.

Sugar

The 1956 crop is expected to produce at least 20,000 tons of sugar, against 12,000 tons in 1955, when exceptional June and July frosts damaged the cane. Consumption, which is increasing, is est mated at 23,000 to 25,000 tons. Imports have been necessary for several years to satisfy industrial workers.

To reduce the risks from frost, Bank of Paraguay credit policy has favoured cultivation closer to the existing mills and there is a complementary plan to establish a State sugar mill in the north. The renovation of existing mills, now overdue, would cost over £400,000. The Ministry of Agriculture are examining the needs for mechanisation of the cane growers at Villa Rica.

Wheat and rice

Because the three-year-old experiment with selected subtropical wheats has wilted from lack of mechanisation, the Government propose a triangular association between wheat, rice (already mechanised and buoyant) and livestock farming. The normal wheat imports from Argentina, which have become a political necessity, were frozen until the transition could be completed from *péronista* ' economic union ' to multilateral bases for settling payments.

Spec. Reg. Inform. Serv.

CUBA

Rice

Rice production in Cuba is menaced by a disease that is causing serious losses in most areas of that country. This disease is particularly serious in some areas of Camaguey Province. It has increased and spread rapidly during the past two or three years. It was first noted in Camaguey Province, where it is now quite common, and diseased plants have been observed in Orientes and Pinar Del Rio Provinces.

The U.S. varieties Century Patna, Bluebonnet, Toro, Sunbonnet, Magnolia and Rexoro have been damaged more severely than the local Honduras (Zayas Bazan) variety. The difference has been so great that in some areas banks have refused to make production loans except for growing Honduras. This caused a marked increase in the acreage and production of Honduras and a corresponding decrease in acreage and production of the U.S. varieties in 1956. There will be a reduction in total production in Cuba in 1956 compared to 1955.

The cause of this disease is unknown, although the symptoms and the way it has spread suggest that it is caused by a virus transmitted by an insect vector. It has not been observed in the U.S.A. The disease is serious and precautions may be necessary to prevent introducing it into that country.

FRANCE

Crop estimates

The French Ministry of Agriculture has published the following estimates of the 1956 grain crops:

Wheat: 48,650,400 quintals, compared with 103,646,600 quintals in 1955.

Barley: 50,662,200 (26,706,100).

Rye: 4,570,000 (4,403,600).

Oats: 41,208,100 (36,396,200).

Mixed grains: 2,153,400 (1,496,500).

The wheat crop improved during July, the Ministry reports. Harvesting of barley will be hampered by the fact that large areas have been laid low by heavy winds. Excellent yields are expected for oats and good prospects exist for maize.

Though no figure was given by the Ministry, the maize crop may exceed last year's crop by one-third. The Ministry also forecasts an abundant rice crop.

CANADA

Better than average crop yields are in prospect for the prairie provinces, barring the occurrence of an early frost, the Dominion Bureau of Statistics reported late in August.

Harvesting started early in August and was general later in the month. Crop damage to date has been slight. Pastures generally are in excellent condition.

ENGLAND AND WALES

Agricultural report

Agricultural conditions in England and Wales on 1 August, 1956, have been summarised by the Ministry of Agriculture, Fisheries and Food.

The storms at the end of July have laid considerable areas of barley and, to a lesser degree, oats. Wheat has withstood the weather well. Wheat and barley crops are generally satisfactory and yields per acre are expected to be above average, but oats are thin in many districts and are expected to yield a little below average. Potatoes and root crops made good progress and satisfactory yields are expected. Haymaking was delayed by weather and the quality has been adversely affected. Grass was plentiful; cattle and sheep have done well.

Cereal and pulse crops

Wheat is a promising crop, although take-all, eyespot and mildew are reported from several areas. Storms with gale force winds caused some lodging, but on the whole crops are standing well. On the basis of crop conditions at the end of July, the yield of wheat is expected to be 25.1 cwt. per acre, as compared with a five-year average (1951–55) of 23.5 cwt. and a yield of 26.7 cwt. in 1955.

Barley improved during the month and crops are generally good, but considerable areas have been laid by wind and rain—some of the heavier crops rather badly. Mildew is reported from a few areas. The yield of barley is expected to be 23.2 cwt. per acre, as compared with a five-year average of 21.9 cwt. and a yield of 25.4 cwt. in 1955.

Oats are variable. Crops are thin in many areas and widespread damage by frit fly is reported. Some lodging occurred during the gales at the end of the month. The yield of oats is forecast at 19.8 cwt. per acre, as compared with a five-year average of 20.3 cwt. and a yield of 22.5 cwt. in 1955.

Rye is a satisfactory crop which has stood well. The yield is forecast at 19.6 cwt. per acre, as compared with a five-year average of 19 cwt. and a yield of 20.4 cwt. in 1955.

Root crops

Conditions for lifting *early potatoes* were generally favourable. Tubers were of good quality and condition and yields per acre were estimated to be appreciably above average.

Second early and *maincrop potatoes* made good growth during the month. Blight is reported from some areas. Gales caused damage to haulms in several areas, but the damage may not seriously affect yields, which are expected to be above average.

Sugar-beet improved with the rain during the month and crops are generally healthy and vigorous. The yield per acre of roots is expected to be about average.

Turnips and *swedes* made good growth during the month and are generally healthy. Weeds are prevalent. The yield per acre of turnips and swedes is expected to be about average.

Mangolds improved during the month, but some crops are patchy and uneven owing to the earlier dry conditions. Wet weather has encouraged weed growth. The yield per acre is expected to be about average.

Hay

Rain has hindered the hay harvest in most parts of the country and haymaking has been difficult and protracted. Delay in cutting and carrying has lowered the feeding value in most areas, but in a few districts in Wales and the south-west of England crops were gathered in satisfactory condition. The yields of *hay from temporary grass* and *lucerne hay* are now forecast at 28.4 cwt. per acre and 39.8 cwt. per acre respectively, as compared with yields of 31.2 cwt. and 44.3 cwt. in 1955. The yield of *hay from permanent grass* is expected to be 20 cwt. per acre, as compared with 22.7 cwt. in 1955.

Pastures

Grass has grown well during the month and the condition of pastures is generally satisfactory.

FRENCH WEST AFRICA

Peanuts

Commercial peanut production in French West Africa reached a record high of about 860,000 short tons in 1955, according to a speech by the High Commissioner, in which he summarised the economy of the Federation. This compares with a commercial production of around 630,000 tons in 1954 and 793,000 tons in 1953.

In Senegal, the major producing area, marketings from 1955 crop were reported at 595,000 tons, against 430,000 and 606,000 tons marketed from the 1954 and 1953 crops respectively. Niger broke its record with nearly 143,000 and Sudan's marketings were around 94,000 tons.

Commercial palm production also was high with about 94,000 tons of palm kernels and 20,000 tons of palm oil.

As an example of the real beginning of industrialisation in French West Africa the High Commissioner reported that the oil mills of Senegal now produce 110,000 tons of peanut oil each year.

YUGOSLAVIA

The 1956 fresh prune crop in Yugoslavia is unofficially forecast at 330,000 short tons. This is the ' off-year ' in Yugoslav prune production, following last year's large crop of 996,000 tons.

Dried prunes

Dried prune production in 1955 was estimated at 25,800 tons. Should the 1956 fresh prune crop turn out as now forecast (which is equivalent to one-third of the size of last year's crop), the 1956 dried prune pack would be less than one-third of the 1955 pack, since the percentage dried is also reduced in the case of a smaller crop. In this event, Yugoslavia would be unable to supply Western European countries in 1956–57 and maintain the recent level of exports to the Soviet bloc.

INDIA

Cashews

The 1956 Indian cashew forecast, which has been subject to widely varying estimates, is now indicated at 66,000 short tons, unshelled. Contrary to earlier expectations, an above-average crop is now estimated. Average production (1949–53) is 57,000 tons. Estimated 1955 production has also been revised upward and is now considered to have been 77,000 short tons —the largest on record.

Foreign Cr. Mark.

SWEDEN

Wheat

A record wheat crop for this year of 886,000 tons is forecast by the Swedish Agricultural Marketing Board. This crop comprises 559,000 tons of autumn-sown wheat and 327,000 of spring wheat and compares with last year's total yield of 717,000 tons.

The total cereal crop is estimated at 1,151,000 tons, against 887,000 last year, when the very low output was due to poor weather.

INTERNATIONAL

Cacao

The world cacao economy has been in a profoundly disturbed condition. Price fluctuations have been greater than for all other major food commodities. Between 1946 and 1953 it was already clear that the shortage of supplies of cacao beans and the relatively high prices would lead to long-term developments harmful both to producers and consumers. Since 1953 the situation has become critical, inadequate supplies resulting in inordinately high prices and disturbing fluctuations, and ultimately in a precipitous fall in consumption and prices. Although the current cacao crop will be only slightly (1–2%) higher than the crops of 1950 and 1951, prices are now about 23 U.S. cents a pound, as compared with an average of 34 cents during those two years—notwithstanding the growth of population and income in all the major consuming countries.